Mining the Pebble Deposit:

Issues of 404 compliance and unacceptable environmental impacts

Prepared for the Bristol Bay Native Corporation and Trout Unlimited

by

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Cover photograph: Aerial view of areas immediately south of the proposed mine pit for the first 25-year phase of mining the Pebble deposit. All areas within this photograph would be excavated or filled with waste rock under a plan depicted by Wardrop (2011). Exploratory drilling operations can be seen in the foreground and in the distance. Photograph taken by the authors, August 12, 2011.

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Executive Summary

A number of groups have petitioned the United States Environmental Protection Agency (EPA) to initiate action under Section 404(c) of the Clean Water Act (CWA) to protect the fisheries of Bristol Bay from large-scale hardrock mining of the Pebble deposit[3] in the headwaters of the Kvichak and Nushagak River drainages. The Bristol Bay Native Corporation and Trout Unlimited asked the authors of this report to assess the potential threats posed by mining the Pebble deposit, the largest known ore body in those headwaters, and to assess the applicability of CWA authorities to reduce or eliminate those potential threats to Bristol Bay fisheries and associated resources.

We begin this report with background on the region within which the Pebble deposit exists, the Pebble deposit itself, and on publicly available plans to mine it. We then describe the purpose and goals of Section 404(c) of the CWA, followed by a discussion of the CWA 404 permitting process, and how it relates to mining and other aspects of the CWA, including Section 404(c). From there we evaluate known information about mining the Pebble deposit, and whether doing so could comply with the CWA 404(b)(1) Guidelines[4] (hereinafter referred to as "the Guidelines"), concluding that existing plans could not be permitted because of impacts to salmon habitat, likely toxicity to aquatic life, and the likely need to treat in perpetuity seepage and runoff from mine-related dredged and/or fill material. We conclude that from a regulatory standpoint these impacts should be considered environmentally unacceptable, particularly when compared with the impacts that have led EPA to initiate 404(c) actions in the past.

We then propose that EPA proactively impose three restrictions on regulated discharges of dredged or fill material (*i.e.*, mine waste) that would result from mining operations of the Pebble

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[3] The Pebble Project proponent describes its project as including the Pebble deposit and surrounding claims (http://www.northerndynastyminerals.com/ndm/NewsReleases). For purposes of this report, we consider the Pebble deposit to include the adjacent claims, as well.

[4] Although appearing the Code of Federal Regulations as "Guidelines," these are binding federal regulations and not optional guidance.

deposit. These restrictions include: 1) a prohibition on discharge of dredged or fill material into salmon habitat; 2) a prohibition on the discharge of dredged or fill material that does not meet testing requirements demonstrating that such material is not toxic to aquatic life; and 3) a prohibition on the discharge of dredged or fill material runoff or seepage from which would require treatment in perpetuity. These restrictions are rooted in well-established precedents and long-standing practices and policies within the CWA 404 program, and thus routinely are applied to 404 permits in the Pacific Northwest and elsewhere. Asserting these restrictions proactively furthers the goals of the Clean Water Act by providing certainty, and associated time and money savings, to industry and the public, including the indigenous peoples of the region to whom the United States has a trust responsibility, as to what will be required of any proposed plan to mine that deposit.

In reaching our conclusions and recommendations, we rely on information developed by the present sponsors of the proposed Pebble Project that describe the location, dimension, and mineral characterization of the Pebble deposit, as well as the location and dimensions of potential tailings impoundments, waste rock disposal areas, port facilities, access roads, and pipelines. To characterize project planning and designs, we have relied primarily upon "The Preliminary Assessment of the Pebble Project Southwest Alaska" prepared by Wardrop (February 17, 2011) for Northern Dynasty Minerals Ltd.[5] Similarly, the authors have relied on natural resource characterizations that have been used or adopted by agencies of the State of Alaska, federal agencies, and those published in scientific journals. As new information becomes available, from the Pebble Project sponsors or other sources, we will reevaluate and update this report.

We thank the Bristol Bay Native Corporation and Trout Unlimited for supporting our preparation of this report. The assumptions and conclusions reported herein are those of the authors, and are not intended to represent those of the Bristol Bay Native Corporation, Trout Unlimited, or any other persons or organizations.

I. Introduction and background

The Pebble ore deposit in southwest Alaska has been proposed as the site for a very large mining operation to extract copper and associated metals from an extensive deposit.[6] The deposit lies in the pristine and undeveloped headwaters of three rivers that support anadromous salmon fisheries[7] (Figure 1), and that are tributaries of the Bristol Bay watershed. This watershed supports the largest remaining salmon runs in the United States, and the largest remaining sockeye salmon run on earth (Ruggerone, et.al. 2010, and Woody and O'Neal 2010). According

[5] The Wardrop (2011) report conforms to the standards set out in National Instrument 43-101 which is a national instrument for the *Standards of Disclosure for Mineral Projects* within Canada. The Instrument is a codified set of rules and guidelines for reporting and displaying information related to mineral properties owned by, or explored by, companies which report these results on stock exchanges within Canada.

[6] http://www.hdgold.com/i/media/northern/ND-Pebble.htm

[7] The North Fork Koktuli River, South Fork Koktuli River, and Upper Talarik Creek are waters that support anadromous fishes, such as salmon, and are mapped as such in the Alaska Department of Fish and Game's Anadromous Waters Catalogue at http://www.adfg.alaska.gov/AnadromousRegPDFs/swt/ILI250.PDF

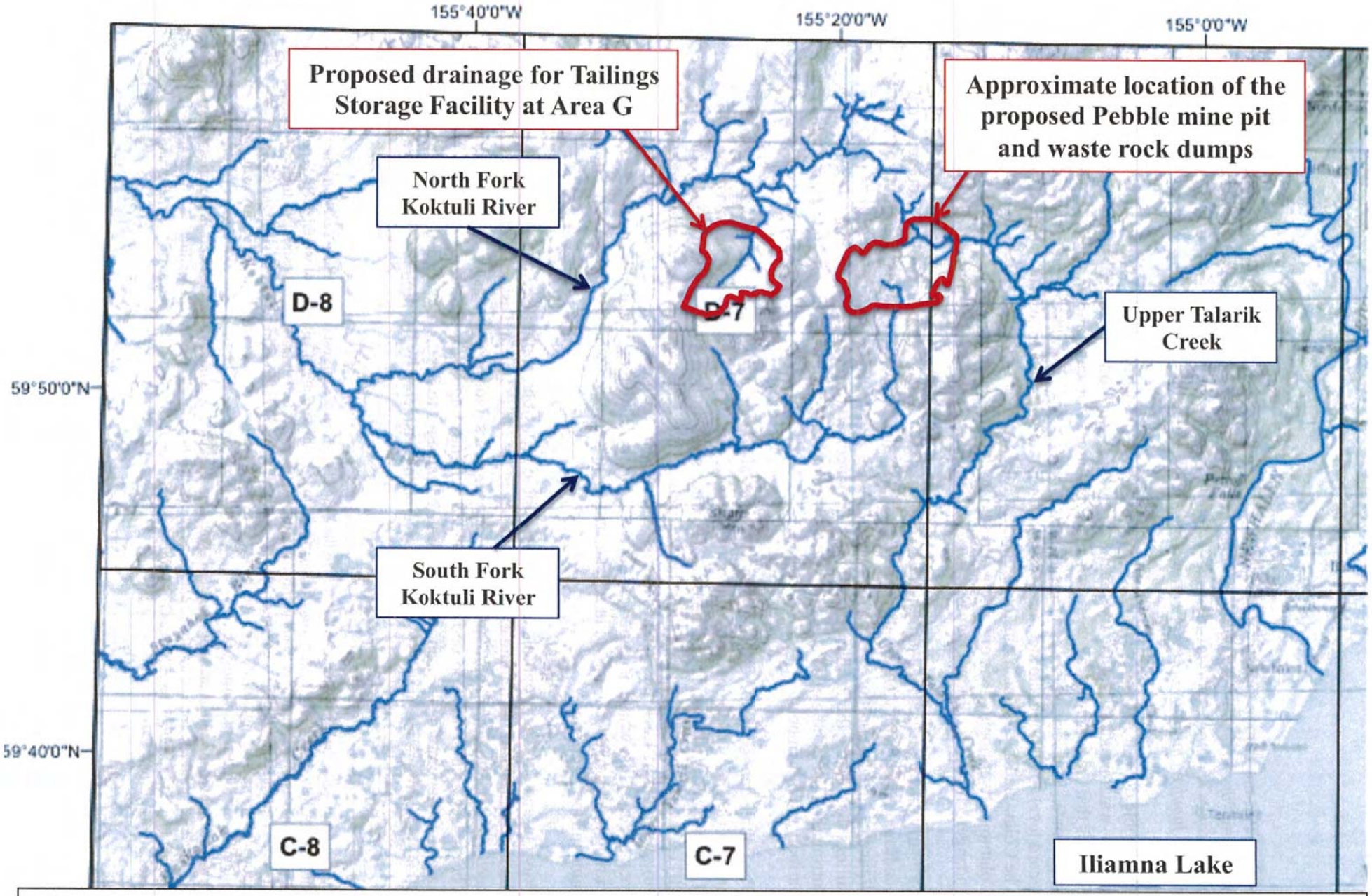

Figure 1: Anadromous Waters documented by the Alaska Department of Fish and Game (2010) in the vicinity of the Pebble deposit. Proposed mining areas from Wardrop (2011)

to the EPA, the salmon industry in Alaska is the State's largest nongovernmental employer, providing "*approximately 70,000 seasonal and full-time jobs, and is the second leading generator of revenue (wetlands-dependent commercial and sport fishing in Alaska generate several hundred millions of dollars annually)*" (U.S. EPA et.al. 1994).

The Pebble deposit itself is overlain by extensive areas of hydrologically connected wetlands, shallow-water ponds, and tributary streams (Figure 2). The commercial, subsistence, and sport fisheries that are supported by these waters are resources of local, national, and international importance. The sockeye salmon runs alone (Salomone et.al. 2007) are greater now than the record levels of salmon and steelhead trout that migrated up the Columbia River historically. The Columbia River salmon runs have declined roughly 96% since the 1850's and, as a result, 12 Columbia River populations of salmon and steelhead have been declared threatened or endangered under the Endangered Species Act (U.S. Government Accounting Office 2002).

Similarly, the drainages that surround the Pebble deposit include tributaries that are documented anadromous fish habitat (Alaska Department of Fish and Game 2011), and one or more of these drainages has been proposed to be permanently impounded to serve as storage facilities for tailings that mining the Pebble deposit would produce (Wardrop 2011). The entire area surrounding the Pebble deposit also serves as habitat for a variety of wildlife species, including caribou and brown bear.

The Pebble deposit itself contains large quantities of copper, as well as lesser amounts of gold and molybdenum. The concentration of recoverable metals is relatively low per ton of ore (0.38-0.46% copper, 0.011 ounces/ton gold, 182-234 parts per million (ppm) molybdenum; Wardrop 2011). Approximately 1.4% of the processed ore would be shipped off as a concentrate. At a stripping ratio of 1.5:1, this equates to approximately 0.6% of all the material (overburden, waste rock and ore) that would be mined. If developed to its full extent, it would be by far the largest mining operation ever proposed in Alaska, and at full build-out would be the largest hardrock mine in North America.[8]

Previous and existing proposals to mine the Pebble deposit have proposed an open pit for at least the initial phases of the mining effort. The surface area of the pit and associated facilities has been estimated to cover approximately two square miles (Northern Dynasty Mines, Inc. 2006a). The surface area of the proposed waste rock and tailings impoundments are considerably larger,[9] and have been previously proposed to fill entire drainages to depths of over 700 feet. More than 30 tailings storage facility (TSF) options have been considered by the project sponsor (Wardrop

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[8] At full build-out, the mine would be larger than the Bingham Mine, the largest man-made excavation on earth (http://www.kennecott.com/library/media/TeacherGuide.pdf). The volume of tailings that would need disposal range as high as 11.9 billion tons. This number could grow as efforts to delineate the deposit in Northern Dynasty Minerals Ltd. surrounding claims continue. Put in perspective, this quantity of material placed on the 310-acre National Mall in Washington, DC, would rise to well over 15,000 feet, and does not include roughly twice that volume in overburden and waste rock.

[9] In water rights applications made by Northern Dynasty Mines, Inc. in 2006, two tailings storage facilities were proposed for an initial proposal to mine a portion of the Pebble deposit. These storage facilities in "Area A" (Knight Piesold Ltd. 2006a) and "Area G" (Knight Piesold Ltd. 2006b) had surface areas of 4200 acres and 2300 acres, respectively.

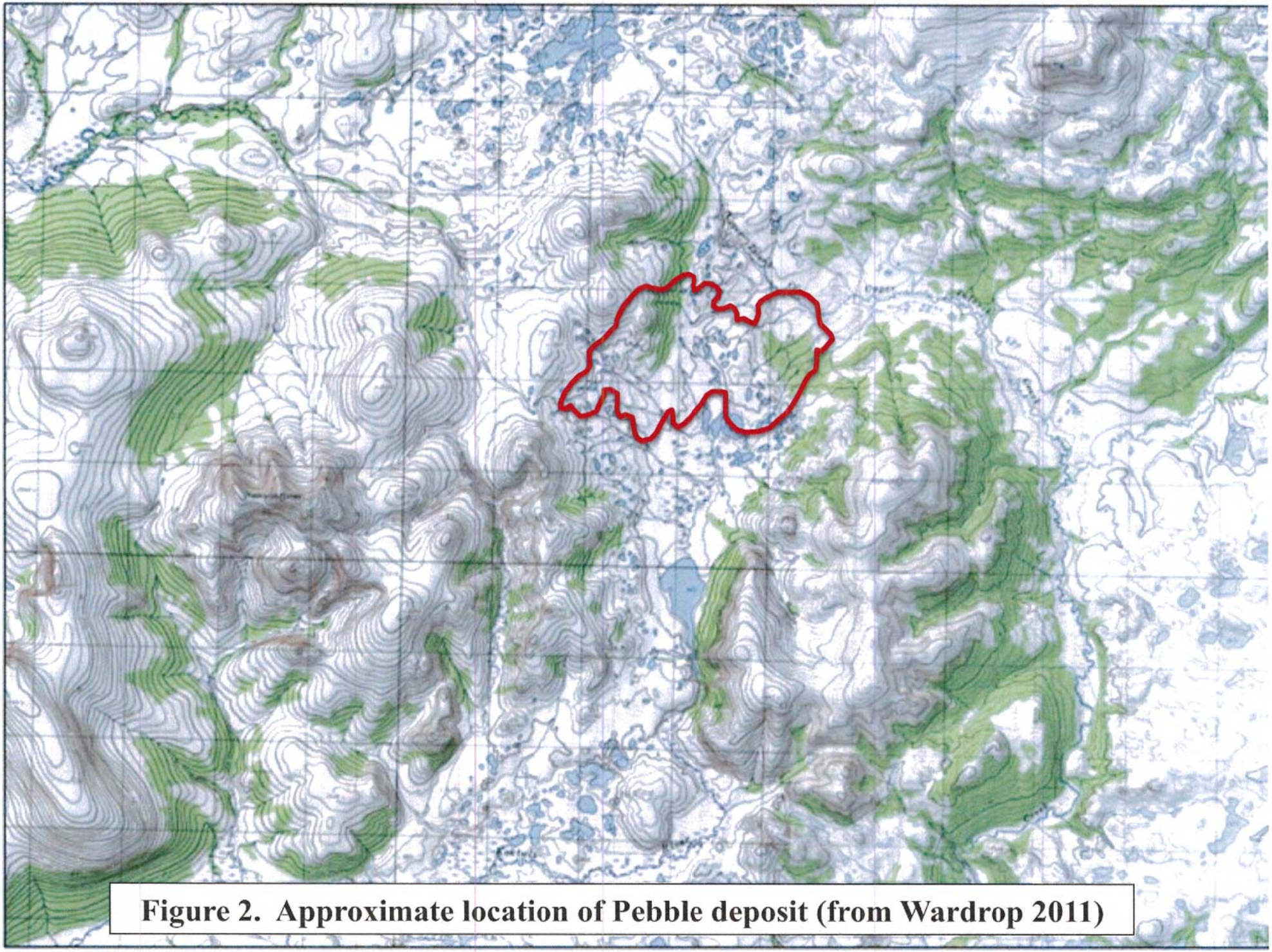

Figure 2. Approximate location of Pebble deposit (from Wardrop 2011)

2011). A water treatment plant would treat excess water in the TSF and discharge it to one or more nearby drainages (North and South Forks of the Koktuli River, and Upper Talarik Creek).

In addition, the project would include an 86-mile transportation corridor connecting the mine to a proposed port on Cook Inlet, including an access road and as many as four parallel pipelines for copper-gold concentrate, reclaim water, natural gas, and diesel fuel (Northern Dynasty Minerals, Ltd. 2011). The ore concentrate would be piped as a slurry to Cook Inlet, dewatered, and loaded on ships (up to 1.1 million tons per year; Wardrop 2011), and recovered water would be piped back to the mine site for storage in the tailings storage facility (TSF). The road would cross approximately 120 streams (Northern Dynasty Mines, Inc., 2005c). A 378-megawatt power plant would also be constructed at or near the mine site to support the mining effort (Wardrop 2011).

As noted above, mining the Pebble deposit would produce small quantities of recoverable metals per ton. Consequently, it would generate vast amounts of overburden, waste rock and tailings. Indeed, if the deposit were fully exploited as presented in some plans, mining could generate up to 23 billion tons of such overburden, waste rock, and tailings (Wardrop 2011). At a projected recovery rate of roughly 87% for copper (Wardrop 2011), the tailings would contain billions of pounds of copper in impoundments constructed in, above, and adjacent to spawning and rearing habitats for anadromous fishes. Copper is toxic at very low concentrations to early life stages of anadromous fishes and tailings storage facilities containing copper pose a potential threat to downstream fishery resources should these facilities ever leak or fail.

Given the extent of wetlands, ponds, and tributary streams overlying the deposit and within adjacent drainages, it is clear that mining the Pebble deposit will most certainly entail discharges of fill material into regulated "waters of the United States," including wetlands [40 CFR 230.3(s)(1-7)].

II. The Clean Water Act and Section 404(c)

The goal of the Clean Water Act (CWA) is to restore and maintain the chemical, physical, and biological integrity of the nation's waters so that they can support "*the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water.*"[10] To further this goal, the CWA regulates, among other things, discharges of dredged or fill material into waters of the United States;[11] dredged or fill material is defined as a pollutant under the Act. The United States Army Corps of Engineers (Corps) has the primary regulatory authority to implement this "section 404" permitting program, with oversight from the EPA as set out in Section 404(c).

Section 404(c) authorizes EPA to prohibit or withdraw the specification, or deny, restrict, or withdraw the use for specification, of any defined area as a disposal site for dredged or fill

[10] 33 U.S.C. 1251. Section 101(a)(2)

[11] Waters of the United States are defined in federal regulations at 40 CFR 230.3(s)(1-7), and include tidal waters, tributary rivers and streams, lakes, adjacent wetlands, and "other waters."

material whenever the EPA Administrator "*determines that the discharge of dredged or fill material is having or will have an 'unacceptable adverse effect' on municipal water supplies, shellfish beds and fishery areas (including spawning and breeding areas), wildlife, or recreational areas*"[12]

In determining what constitutes an "unacceptable adverse effect," EPA is directed to consider relevant portions of the Guidelines (40 CFR 230).[13] These Guidelines help govern EPA's 404(c) actions. In the absence of 404(c) procedures, the Guidelines are the mandatory regulations that determine if discharges of dredged or fill material can be permitted, and would, in part, determine whether discharges from a proposal to mine the Pebble deposit could be authorized by the Department of the Army pursuant to Section 404 of the CWA. A failure to comply with the Guidelines is, therefore, justification for initiation of Section 404(c) procedures and also grounds for permit denial.

Furthermore, the CWA authorizes the EPA to exercise its 404(c) obligations in a proactive manner outside of a specific permit application. EPA's implementing regulations reiterate this statutory authority to proactively protect waters of the U.S. from dredged or fill material, providing that EPA act "*before a permit application has been submitted to the Corps.*"[14] In its preamble explanation of these regulations EPA explained that such a proactive approach "*will facilitate planning by developers and industry ... eliminate frustrating situations in which someone spends time and money developing a project for an inappropriate site and learns at an advanced stage that he must start over [and] facilitate comprehensive rather than piecemeal protection of wetlands.*"[15]

III. The Clean Water Act Section 404 Permitting Process

Discharges of dredged or fill material into waters of the United States, including wetlands, authorized under Section 404 of the CWA, must comply with the Guidelines. Consistent with the overall goals of the CWA, the purpose of the Guidelines is to "*restore and maintain the chemical, physical, and biological integrity of waters of the United States through the control of discharges of dredged or fill material*" [40 CFR 230.1(a)]. If such discharges can be avoided, they should be avoided "*unless it can be demonstrated that such a discharge will not have an unacceptable adverse impact either individually or in combination with known and/or probable impacts of other activities affecting the ecosystems of concern*" [40 CFR 230.1(c)].

In particular, areas that contain special aquatic sites, such as those wetlands, shallow vegetated ponds, and riffle-and-pool stream reaches that are present at the Pebble deposit, are such ecosystems of concern.[16] The Guidelines state "*From a national perspective, the degradation or destruction of special aquatic sites, such as filling operations in wetlands, is considered to be*

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[12] 33 U.S.C. 1344(c).
[13] See Definitions: 40 CFR 231.2(e)
[14] 40 C.F.R. 231.1(a).
[15] 44 Fed. Reg. 58076, 58077 (Oct. 9, 1979).
[16] "Special aquatic sites" are defined in the Guidelines at 40 CFR 230.3(q-1), and discussed further in Subpart E of the Guidelines (Potential Impacts on Special Aquatic Sites – 40 CFR 230.40-45).

among the most severe environmental impacts covered by these Guidelines. The guiding principle should be that degradation or destruction of special sites may represent an irreversible loss of valuable aquatic resources" [40 CFR 230.1(d)].

As lead permitting authority under Section 404, the Corps is directed to utilize the Guidelines (40 CFR 230) in making its findings of compliance with the CWA. In the case of mining the Pebble deposit, if the Corps were to determine that the discharges of fill material associated with that mining effort would violate any of the restrictions on discharges of dredged or fill material into waters of the United States, the Corps would be required under the regulations to deny the permit application.[17] Furthermore, even if the discharges associated with the proposed mining are found to comply with these regulations, the Corps is further directed to deny the application if, in the opinion of the Corps, the project would be contrary to the public interest (33 CFR 320.4).

When a permit application is pending, the Corps uses the project specifics of that application (as does EPA in its separate authority to review such applications) to evaluate compliance or lack of compliance with the Guidelines, as well as the Corps' public interest determination. In the absence of a permit application, the evaluation of mining the Pebble deposit requires a broader view to assess whether any otherwise practicable means of achieving the basic purpose of extracting copper and associated metals could qualify for permitting under the Guidelines.

Whereas balancing the factors of its public interest determination is solely the responsibility of the Corps, it is worthwhile to consider these public interest factors in assessing whether any potentially feasible proposal to mine the Pebble deposit would qualify for a federal permit pursuant to Section 404 of the CWA.[18]

A. Discharges of dredged or fill material into waters of the United States

Definition of dredged or fill material

Before continuing with a discussion of the specific tests and requirements of the Guidelines, it is important to understand how the definition of fill material has evolved over the nearly 40-year existence of the CWA 404 program. Historically, the Corps refused to consider any material as fill if it did not have a "primary purpose." The Corps did not want to be in the business of regulating solid waste discharges to waters of the United States. EPA did not share this position

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[17] See Corps regulations at 33 CFR 323.6(a): "*The district engineer will review applications for permits for the discharge of dredged or fill material into waters of the United States in accordance with guidelines promulgated by the Administrator, EPA, under authority of section 404(b)(1) of the CWA. (see 40 CFR Part 230.) Subject to consideration of any economic impact on navigation and anchorage pursuant to section 404(b)(2), a permit will be denied if the discharge that would be authorized by such a permit would not comply with the 404(b)(1) guidelines. If the district engineer determines that the proposed discharge would comply with the 404(b)(1) guidelines, he will grant the permit unless issuance would be contrary to the public interest.*" (emphasis added)

[18] See Corps regulations regarding its public interest review at 33 CFR 320.4(a)(1): "*All factors which may be relevant to the proposal must be considered including the cumulative effects thereof: among those are conservation, economics, aesthetics, general environmental concerns, wetlands, historic properties, fish and wildlife values, flood hazards, floodplain values, land use, navigation, shore erosion and accretion, recreation, water supply and conservation, water quality, energy needs, safety, food and fiber production, mineral needs, considerations of property ownership and, in general, the needs and welfare of the people.*"

and considered any material to constitute fill material, regardless of its origin, if its discharge would alter the reach of the waters of the United States, including wetlands.

On May 9, 2002, the EPA and Corps of Engineers adopted a joint definition of fill material that effectively eliminated the "primary purpose" test. With respect to mining, the new definition specifically included "*placement of overburden, slurry, or tailings or similar mining-related materials ....*" as fill material subject to the requirements of CWA Section 404 (67 FR 31192). The agencies' action provided mining waste a "regulatory home" at the federal level given that EPA's solid waste law, the Resource Conservation and Recovery Act (which currently regulates hazardous wastes and municipal wastes), was precluded by Congress in 1980 (via the Beville Amendment) from considering certain mining wastes (*e.g.*, overburden, tailings, and waste rock) as potentially hazardous material.

By regulation, all fill material, including that produced from mining operations, must be determined to be clean fill material in order to be considered for discharge into waters of the United States. The preamble to the 2002 Fill Rule states that "*The 404(b)(1) guidelines provide a comprehensive means of evaluating whether any discharge of fill material, regardless of its purpose, is environmentally acceptable and therefore may be discharged in accordance with the Clean Water Act. Where the practicable alternatives test has been satisfied and all practicable steps have been taken both to minimize effects on the aquatic environment and to compensate for the loss of aquatic functions and values, we believe the section 404 permitting process is adequate to ensure protection of the aquatic ecosystem for any pollutant that fills waters.*"[19]

It is important to remember that although the Guidelines specifically regulate discharges of dredged or fill material, the environmental effects of other aspects of a project that are enabled by the regulated discharge(s)[20] are evaluated and included in the final determination of compliance and/or acceptability of any adverse environmental impacts.

Waters of the United States, including wetlands

Section 404 regulates point-source discharges of dredged or fill materials into "waters of the United States," including wetlands. These waters are broadly defined, and cover tidal and other traditionally navigable waters, including lakes, rivers and other tributaries to navigable waters, interstate waters, certain intra-state waters, and wetlands that are adjacent to navigable waters and their tributaries [40 CFR 230.3(s)(1-7). The areas that are likely to constitute regulated waters at or near the Pebble deposit include tributaries to navigable waters, open water ponds

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[19] Final Revisions to the Clean Water Act Regulatory Definitions of "Fill Material" and "Discharge of Fill Material." Federal Register /Vol. 67, No. 90 /Thursday, May 9, 2002 /Rules and Regulations. page 31133

[20] The extent to which portions of a project that are not in regulated "waters," including wetlands, or that do not constitute discharges to same (such as excavation) are, nonetheless tied to findings of compliance related to whether these project features are directly enabled by the permitted discharges. For example, if the upland portions of a project are not feasible 'but for' the discharges, then those features and their impacts are included in determinations of compliance with the Guidelines. In the case of mining the Pebble deposit, the excavation of the pit, and the placement of material on uplands for a) portions of tailings storage facilities, b) access roads, and c) any other project features might otherwise not require federal 404 authorization if the overall project could be constructed without the need for authorized discharges into regulated "waters," including wetlands. However, there seems to be little question that mining the Pebble deposit is not feasible without authorized discharges pursuant to Section 404 of the Clean Water Act (Wardrop 2011).

that are hydrologically connected to those tributaries, and wetlands that are adjacent to these tributary streams and open-water areas.

The outer boundaries of wetlands that are adjacent to other regulated waters are delineated using methods described by the Corps in its 1987 Wetlands Delineation Manual (Environmental Laboratory 1987), and in Alaska, additional guidance is provided in a regional supplement to that Manual (U.S. Army Corps of Engineers 2007). In the absence of a formal determination of jurisdiction by the Corps or EPA, other sources of information, such as National Wetland Inventory maps can assist in assessing the likelihood that jurisdictional wetlands are present, but the exact reach and extent of such areas generally cannot be reliably determined without on-site sampling and verification (Environmental Laboratory 1987).

United States Supreme Court rulings[21] have attempted to clarify the reach and extent of Clean Water Act jurisdiction over isolated water bodies and non-navigable and/or seasonal or ephemeral drainages. It is unlikely that these rulings would apply to the streams, open-water areas, and adjacent wetlands that overlie the Pebble deposit or that are within nearby drainages being considered for tailings storage facilities or other project features. These headwater areas are interconnected hydrologically, and all provide flows that ultimately reach Bristol Bay.

The Clean Water Act Waste Treatment Exclusion

There has been continuing confusion regarding which aspects of the CWA regulations apply to proposed discharges of mining waste products to waters of the United States. EPA's New Source Performance Standards (pursuant to Section 402 of the CWA) prescribe effluent limits, such as 20 parts per million (ppm) Total Suspended Solids (TSS), for froth-flotation mills that discharge a slurry of tailings mixed with mill process water to waters of the United States. However, the revised definition of fill material pursuant to Section 404 of the CWA, as described above, now includes "*the placement of overburden, slurry, or tailings or similar mining-related materials ....*" as fill material. In essence, a tailing slurry discharge can be regulated as a wastewater discharge under a CWA Section 402 NPDES wastewater discharge permit for the liquid portion of the slurry and as a discharge of fill material under Section 404 of the CWA for the solids component of the slurry.

Adding to the confusion regarding CWA jurisdiction is what is generally referred to as the Waste Treatment Exclusion (WTE). The WTE relates to a subsection of the definition of the waters of the United States (40 CFR 122.2) that states:

"*Waste treatment systems, including treatment ponds or lagoons designed to meet the requirements of CWA (other than cooling ponds as defined in 40 CFR 423.11(m) which also meet the criteria of this definition) are not waters of the United States. This exclusion applies only to manmade bodies of water which neither were originally created in waters of the United States (such as disposal area in wetlands) nor resulted from the impoundment of waters of the United States. (see Note 1 of this section.)*"

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[21] *Solid Waste Agency of Northern Cook County (SWANCC) v. U.S. Army Corps of Engineers*, 531 U.S. 159 (2001), and *Rapanos v. United States*, 547 U.S. 715 (2006)

Note 1, dated July 21, 1980, states that the underlined sentence has been suspended until further notice. Inasmuch as there has been no further notice, the question of whether or not it is legal to create a waste treatment system in waters of the United States has been not been formally resolved for more than thirty years.

In 1992, EPA put forth a policy[22] that established conditions under which EPA and the Corps could potentially invoke the WTE and apply it to tailings impoundments under consideration for the Alaska-Juneau and the Kensington gold mine projects near Juneau, Alaska. In short, the policy held that if EPA and the Corps determined that the proposed tailings impoundments were found to be the least environmentally damaging practicable alternatives (LEDPA) for treating mine wastes from the two respective projects, and if these proposed mines otherwise complied with the Guidelines, then the waters of the United States that would be altered by constructing these impoundments would be "converted" to non-jurisdictional waste-treatment systems. The "treatment" was considered to be the settling of the tailings solids within the impoundments such that the supernatant process water, along with impounded water and net precipitation, could then be discharged from the impoundments to areas determined to be waters of the United States.

In such cases, effluent limits and WQC would have to be met at the point of discharge from the impoundments rather than at the point of discharge into the impoundments. This distinction is critical, given that the NSPS effluent limit of 20 ppm for TSS could never be met at the point of discharge into the tailings impoundment because the slurry discharge would contain approximately 500,000 ppm TSS.

Following the adoption of this "conversion theory" as expressed in EPA's aforementioned 1992 memorandum, the National Wildlife Federation filed a lawsuit in Alaska District Court claiming it violated the intent of the CWA. Inasmuch as CWA permits for the two mining projects at issue were still under consideration, the case was dismissed for "lack of ripeness" (*i.e.*, no CWA permits had been issued).[23]

In summary, the WTE has never been explicitly invoked for a mining project within EPA Region 10 (Oregon, Idaho, Washington and Alaska) with the possible exception of the Fort Knox gold mine project near Fairbanks. However, this is a "zero discharge" project (no NPDES permit required because there is no wastewater discharge from the tailings impoundment to waters of the United States). Given that there is no discharge, it follows there is no treatment and, therefore, no waste treatment system exclusion per the CWA. The tailings impoundment is a tailings storage facility that also stores mill process water that is recycled to the mill.

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[22] Memorandum on Clean Water Act Regulation of Mine Tailings Disposal from LaJuana Wilcher, EPA Assistant Administrator for Water to Charles E. Findley, Director, Office of Water EPA Region 10, October 2, 1992 (Wilcher memo)

[23] The Alaska-Juneau gold mine project was abandoned after further exploration by the project proponent demonstrated that the ore body had already been fully exploited by earlier mining activities. The Kensington mine was subsequently permitted in 1997 with a dry-stack tailings approach whereby a CWA 404 permit was issued to create an engineered pad designed to receive and control seepage from the tailings. The project proponent thereafter abandoned this permit in favor of discharging mine tailings to a freshwater lake, taking advantage of the revised definition of fill material.

Since the revised definition of fill material was adopted, only one Alaska mine has been permitted that has a CWA 404 permit for discharge of mine tailings to waters of the United States -- the Kensington mine project. Although mine tailings are discharged to a fresh water lake, which has been dammed to create an even larger lake, this lake is still considered a water of the United States. NSPS effluent limits and Alaska WQC must be met at the outlet of the lake, under an interpretation of 40 CFR 230.10(b)(1) which states that no discharge of dredge or fill material shall be permitted that "*causes or contributes, after consideration of disposal site dilution and dispersal, to violations of any applicable State water quality standard.*" Using this interpretation, as embodied in a subsequent 2004 EPA memorandum[24] that replaced the aforementioned 1992 Memorandum (see footnote 17, above), EPA's policy regarding permitting of the revised Kensington project was that the lake (55-acre Slate Lake) was considered the "disposal site" and the entire lake was considered for "site dilution and dispersal."

With regard to mining the Pebble deposit, there is no need for EPA and the Corps to consider invoking the Waste Treatment Exclusion. The application of the Guidelines as recommended in this report, along with the recommended restrictions on discharge of dredge or fill material discussed in Section VI, moot the question of whether the tailings storage facilities should be considered non-jurisdictional waste treatment systems.

B. The 404(b)(1) Guidelines: Restrictions to discharge

The Guidelines list several restrictions that prohibit certain categories of potential discharges of dredged or fill material into waters of the United States, including wetlands. These include:

1. Alternatives:

Proposed discharges are prohibited if a) they can be avoided while practicably achieving the purpose for which the discharge is proposed (in this case, extraction of copper and associated minerals), or b) there is a less environmentally damaging means that is feasible to achieve the same basic purpose that would have been achieved by the proposed discharge. Moreover, if the basic project purpose for which the discharge of dredged or fill material is proposed is not water-dependent and is proposed in a special aquatic site,[25] the regulations establish a presumption that a less-damaging alternative exists unless the project proponent clearly demonstrates otherwise. Water-dependent activities include such facilities as port and marina developments.

Extraction of copper and associated minerals from the Pebble deposit is not a "water-dependent" activity under the Guidelines, and would result in discharges of dredged or fill material into "special aquatic sites," including wetlands, vegetated shallows, and/or riffle and pool complexes.

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[24]Memorandum on Clean Water Act Regulation of Mine Tailings from Diane Regas, Director, Office of Wetlands, Oceans and Watersheds; James A. Hanlon, Director, Office of Wastewater Management; and Geoffrey H. Grubbs, Director, Office of Science and Technology to Randy Smith, Director, Office of Water, Region 10, dated May 17, 2004 (Regas Memo).

[25] The Guidelines state that "*Where the activity associated with a discharge which is proposed for a special aquatic site (as defined in subpart E) does not require access or proximity to or siting within the special aquatic site in question to fulfill its basic purpose (i.e., is not "water dependent"), practicable alternatives that do not involve special aquatic sites are presumed to be available, unless clearly demonstrated otherwise*" [40 CFR 230.10(a)(3)].

Accordingly, project sponsors would need to clearly demonstrate that there are no less environmentally damaging practicable alternatives to achieve the basic purpose of extracting copper and associated minerals. The regulations state that alternative sites can be considered less environmentally damaging practicable alternatives (LEDPA) if they are available and practicable – importantly, this can include alternative ore deposits if they can be acquired, utilized or managed by the project proponent to achieve the basic project purpose, in this case the extraction of copper and associated minerals.[26]

Avoidance of impacts is the primary means of achieving the goals of the CWA, which seeks to eliminate all discharges of pollutants, including dredged or fill material (Yocom et.al. 1989). Alternatives to eliminate or minimize the impacts of such discharges typically considered during the review of any 404 permit application include on-site and off-site alternatives.

2. Water Quality and Endangered Species:

Proposed discharges cannot cause or contribute, after consideration of disposal site dilution or dispersion, to violations of any state water quality or toxic effluent standards, nor can they jeopardize any federally listed threatened or endangered species of animal or plant, or violate any standards associated with any marine sanctuaries. One such animal is the Cook Inlet beluga whale, whose designated critical habitat includes four alternative locations that have been identified as a potential site for a deep-water port for the Pebble Project (50 CFR 226).[27]

Prior to adopting the new definition of fill in May 2002, tailings slurries from froth flotation mills were only regulated at the federal level as a component of mine mill process water per the EPA's New Source Performance Standards (NSPS) effluent guidelines (pursuant to section 402 of the CWA; see 40 CFR 440 subpart J). The Kensington Mine case, however, which the federal government (including the Obama administration) defended before the Supreme Court (and prevailed), held that the tailings (about 50% of the mill process water) are considered fill material subject to CWA section 404. Nevertheless, runoff and seepage from tailings and waste rock piles, now considered fill material, are regulated via an NPDES permit and must meet applicable NSPS effluent limits and WQC prior to discharge to waters of the United States.

3. Significant Degradation:

Proposed discharges cannot cause or contribute to significant degradation of the waters of the United States (emphasis added). The Guidelines list several specific factors that are described as potentially significant degradation, including impacts to fish, wildlife, shellfish, recreation,

[26] In 2010, the Corps of Engineers, Sacramento District, directed a mining applicant to consider an alternative deposit on federal land that the Corps believed might result in less environmental harm than extracting minerals from the source proposed by the applicant. The applicant agreed but was out-bid in its attempt to acquire the alternative deposit, and is seeking authorization for extracting minerals from its originally proposed source. In the case of the Pebble deposit, which was acquired from Cominco in 2001, it would seem appropriate that the Corps or EPA consider other copper deposits that are already or could have been acquired by Northern Dynasty Mines or Anglo-American since at least 2001 as potentially less-damaging alternatives than mining the Pebble deposit.

[27] See Federal Register, Volume 76, Number 69. April 11, 2011. Pages 20180-20214.

and municipal water supplies.[28] Mining the Pebble deposit would involve discharges over large areas of fish and wildlife habitat, and the losses associated with these discharges would be permanent.

It is not mandatory that a proposed project causes a significant adverse impact to trigger this restriction. Rather, if the additive impact of the project to other impacts would result in significant degradation, then the threshold has been met. The final determination of whether the degradation would be significant takes into account the adequacy of mitigation measures (see below).

The bulk of the Guidelines (subparts B-G) describe the factual determinations, evaluations and tests needed to arrive at an overall conclusion regarding the potential for (or risk of) significant degradation. In addition, the EPA Regional Administrator is authorized to require specific testing procedures (40 CFR 230.61) in order to make a determination regarding the suitability of any proposed fill material for discharge to waters of the United States.

Broadly viewed with respect to mining the Pebble deposit, the analysis of potential significant degradation can be broken down into three components:

- Direct impacts on aquatic resources from the placement of dredge or fill material;
- Direct and indirect toxicity impacts on aquatic resources from the discharge of dredge or fill material; and
- Indirect impacts due to hydrologic modifications resulting from the discharge of dredge or fill material.

With respect to potential toxicity, no guidance has been issued by either EPA or the Corps to field offices since adopting the new definition of fill in 2002 regarding how to test and evaluate the potential toxicity of mining wastes. However, EPA Region 10 produced a guidance document for the mining industry entitled *EPA and Hardrock Mining: A Sourcebook for Industry in the Northwest and Alaska* (the Mining Source Book). This document describes in detail the types of information EPA Region 10 generally requires to conduct reviews pursuant to the National Environmental Policy Act (NEPA), NPDES wastewater discharge permit development, and CWA Section 404 permit application reviews.

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[28] See 40 CFR 230.10(c): "*Under these Guidelines, effects contributing to significant degradation considered individually or collectively, include: (1) Significantly adverse effects of the discharge of pollutants on human health or welfare, including but not limited to effects on municipal water supplies, plankton, fish, shellfish, wildlife, and special aquatic sites; (2) Significantly adverse effects of the discharge of pollutants on life stages of aquatic life and other wildlife dependent on aquatic ecosystems, including the transfer, concentration, and spread of pollutants or their byproducts outside of the disposal site through biological, physical, and chemical processes; (3) Significantly adverse effects of the discharge of pollutants on aquatic ecosystem diversity, productivity, and stability. Such effects may include, but are not limited to, loss of fish and wildlife habitat or loss of the capacity of a wetland to assimilate nutrients, purify water, or reduce wave energy; or (4) Significantly adverse effects of discharge of pollutants on recreational, aesthetic, and economic values.*"

The latest edition of the Mining Source Book (U.S. Environmental Protection Agency 2003a) does not directly address the 2002 definition of fill material or associated 404-specific testing requirements. However, it does include recommended testing procedures for determining potential short- and long-term contamination from mine tailings and waste rock (*e.g.*, acid mine drainage, metals leaching) as well as bioassay tests appropriate where discharges of mine wastes to the aquatic environment are proposed.[29]

In addition to producing the Mining Source Book, EPA Region 10 has been instrumental in developing nationally and internationally respected (and emulated) testing protocols for evaluating potentially contaminated dredge material and its suitability for unconfined open-water disposal. Region 10's Sediment Management Program (part of the CWA Section 404 program) helped produce the *Sediment Evaluation Framework for the Pacific Northwest* (SEF 2009), a multi-agency product that details chemical and biological sampling and testing protocols for evaluating dredged material.

Though mining wastes proposed to be discharged to an aquatic environment (*e.g.*, the Pebble Project) are clearly geologically and chemically different from most dredged materials from rivers and harbors, the underlying intent of the SEF is similar to that of the Mining Source Book. The material must be properly tested to determine if the material being evaluated is suitable for unconfined disposal in an aquatic environment (*i.e.*, complies with the CWA Section 404(b)(1) Guidelines). The most important and the ultimate dispositive test, regardless of the chemical constituents of the dredge or fill material at issue, is the bioassay.

4. Mitigation for losses of waters of the United States, including fish and wildlife habitats

The environmental impacts of the proposed discharge must be offset to the maximum extent practicable by mitigation measures, including avoidance, minimization, and compensatory replacement of lost acreage and ecological function. The Guidelines specify that where the project impacts are likely to affect plant and animal populations, impacts can be minimized by taking certain actions such as:

a) Avoiding changes in water current and circulation patterns which would interfere with the movement of animals;

b) Avoiding sites having unique habitat or other value, including habitat of threatened or endangered species; and

c) Using planning and construction practices to institute habitat development and restoration to produce a new or modified environmental state of higher ecological value by displacement of some or all of the existing environmental characteristics.[30]

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[29] The Pebble Limited Partnership has conducted such tests on the various types of ore, tailings, and waste rock, including at least one bioassay on mine tailings water (SRK Consulting, Inc. 2006; Northern Dynasty Mines, Inc. 2005a).

[30] Federal Register, Volume 45, page 85344, December 24, 1980, as amended at Federal Register, Volume 73, page 19687, April 10, 2008.

Furthermore, the National Academy of Sciences found that mitigation measures taken to offset impacts within the 404 permitting program rarely accomplished the environmental improvements that were expected or required, and recommended that impacts be avoided where the habitat that would be affected could not be replaced practicably (National Research Council 2001).

More recently, EPA and the Corps promulgated new regulations regarding compensatory mitigation.[31] These regulations establish specific requirements for offsetting unavoidable impacts from 404 permit actions to wetland and aquatic areas (including streams), and apply to freshwater and marine ecosystems.

Under this 2008 rule, mitigation plans for all compensatory mitigation projects must contain: 1) objectives; 2) site selection criteria; 3) site protection instruments (such as conservation easements); 4) baseline data (for impact and compensation sites); 5) a valid methodology for determining mitigation credit; 6) a work plan; 7) a maintenance plan; 8) ecologically based performance standards; 9) monitoring requirements; 10) a long-term management plan; 11) an adaptive management plan to deal with unforeseen problems; and 12) financial assurances to ensure that the compensatory mitigation plan continues to be successful in the future [see 33 CFR 332.4(c) and 40 CFR 230.94(c)].

In general, the 2008 mitigation rule requires avoidance of impacts where practicable, adopts a watershed approach, and supports implementation through a) project-specific mitigation, b) use of mitigation banks, and c) use of in-lieu fee mechanisms. Mitigation banks and in-lieu fee mechanisms are supported where they are available and appropriate. For example, the Corps, Alaska District, lists three approved mitigation banks, but none of these serve the Bristol Bay watershed,[32] and would not, therefore, be available or appropriate for offsetting impacts to wetland and aquatic areas within the Bristol Bay watershed.

The Alaska District also lists three in-lieu fee sponsors,[33] one of which (the Conservation Fund) is actively seeking to purchase conservation easements within the Bristol Bay watershed (Southwest Alaska Salmon Habitat Initiative), aided, in part, by donations from the Bristol Bay Native Corporation.[34] Presumably, if a proposal to mine the Pebble deposit was determined by the Corps (or by EPA in an independent 404(c) action) to result in unavoidable impacts to salmon habitat, one potential mitigation avenue might be use of such an in-lieu fee, although the magnitude of potential project impacts might preclude such a mechanism.

The 2008 mitigation rule references the May 13, 1994, "Statements on the Mitigation Sequence and No Net Loss of Wetlands in Alaska" issued by the U.S. EPA and the Department of the Army.[35] This interagency guidance recognizes an interagency policy understanding that

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[31] Federal Register / Vol. 73, No. 70 / Thursday, April 10, 2008 / Rules and Regulations: Compensatory Mitigation for Losses of Aquatic Resources. Pages 19594 – 19705.

[32] http://www.poa.usace.army.mil/reg/links.htm

[33] http://www.poa.usace.army.mil/reg/links/Alaska District In-lieu Fee Sponsors.pdf

[34] http://www.conservationfund.org/alaska_hawaii/alaska/southwest_ak_salmon

[35] "Statements on the mitigation sequence and no net loss of wetlands in Alaska." May 13, 1994 Memorandum from Robert H. Wayland (EPA) and Michael L. Davis (Army) to Alvin L. Ewing, Alaska Operations Office, EPA Region 10. See http://www.epa.gov/owow/wetlands/pdf/alask.pdf

compensatory mitigation is not always warranted or practicable within the State of Alaska, even though this policy seems contrary to 1) the goal of the CWA to restore and maintain the physical integrity (reach and extent) of the nation's waters, including wetlands, as well as 2) the national no-net-loss-of-wetlands policy with which it attempts to find harmony. The 1994 policy states, in part, that "*it may not be practicable to provide compensatory mitigation through wetlands restoration or creation in areas where there is a high proportion of land which is wetlands. In cases where potential compensatory mitigation sites are not available due to the abundance of wetlands in a region and lack of enhancement or restoration sites, compensatory mitigation is not required under the Guidelines.*"[36]

In spite of this seemingly contradictory approach to "no net loss," it seems clear that EPA and the federal agency team that participated in the 1994 Alaska Initiative intended this policy to apply primarily to small projects with minimal impacts (U.S. Environmental Protection Agency et.al. 1994). In its background discussion developing this policy, EPA et.al. (1994) notes that 251 individual permits and 654 general permits[37] were issued by the Corps, Alaska District in 1993, of which 11 had been required to provide compensatory mitigation. The 11 projects where compensatory mitigation was required provided 226 acres of wetlands mitigation (an average of approximately 20 acres per project). For the remaining 240 individual and 654 general permitted activities for which compensatory mitigation was not required, the average net loss per authorization was approximately one acre.

Given that projects with an average wetland impact of 20 acres or less (the mitigation ratio for the 11 projects required compensatory mitigation is unknown) were considered large enough for their impacts to require compensatory measures to offset those impacts, it seems clear that EPA's Alaska mitigation policy was not intended to obviate the need to compensate for unavoidable impacts associated with large projects, particularly very large and potentially risky hardrock mining projects in areas supporting anadromous fisheries. Furthermore, the Alaska mitigation policy recognizes that mitigation sequencing still applies and that avoidance of impacts is always required where practicable. Taken together, the 2008 mitigation rule and the 1994 Alaska policy strongly suggest that mining the Pebble deposit would require compensatory mitigation for unavoidable impacts to waters of the United States, and that the mitigation measures would need to offset impacts within the Bristol Bay watershed.

For the purposes of this report, the authors recognize the possibility that EPA or the Corps might adopt a less rigorous standard for compensatory mitigation for proposals to mine the Pebble deposit than might be required for similar proposals in other states, assuming any projects of similar magnitude were ever to be considered. Similarly, the authors recognize that EPA or the Corps might also be subject to greater flexibility in determining the environmental acceptability of unmitigated losses of habitat in Alaska than might be adopted in other States. However, the sheer size and potential impacts of the proposals for mining the Pebble deposit should moot these policy differences.

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[36] Alaska wetlands initiative: summary report. May 13, 1994. http://www.epa.gov/owow/wetlands/pdf/alask.pdf

[37] General permits, such as Nationwide General Permits are authorizations issued by the Corps for minor activities that the Corps has determined would have minimal impacts individually and cumulatively. These general permits have strict acreage limitations, and are typically well under one acre.

In any event, such analyses should not affect determinations of whether or not a project causes or contributes to significant degradation of the waters of the United States. In fact, in the absence of adequate compensatory mitigation measures, large-scale direct, secondary, and/or cumulative impacts, such as those associated with mining the Pebble deposit, would necessarily be viewed as more significantly adverse and less acceptable environmentally.

5. Sufficiency of information

In addition to the specific restrictions listed above, the regulations provide that the Corps make a finding of non-compliance (*i.e.*, deny the permit application) where there is uncertainty regarding compliance. The Guidelines at 40 CFR 230.12(iv) require that a proposed discharge be specified as failing to comply with the requirements of these Guidelines where "*there does not exist sufficient information to make a reasonable judgment as to whether the proposed discharge will comply with these Guidelines.*" In other words, if a District Engineer could not determine if a large mining project represented the least environmentally damaging practicable alternative (LEDPA) or if it would or would not cause or contribute to significant degradation of the waters of the United States, the regulations would direct the Corps to deny the permit application.

IV. "Aquatic Resources of National Importance"

The Corps of Engineers receives thousands of permit applications each year for authorization under Section 404 of the CWA.[38] EPA staff routinely review Corps public notices regarding such permit applications for compliance with the Guidelines. Pursuant to Section 404(q) of the Clean Water Act, EPA entered into a Memorandum of Agreement (MOA) with the Corps of Engineers establishing policies and procedures that both agencies agreed to follow in the event there were disagreements over the authorization of discharges of dredged or fill material for a particular application for a Department of the Army permit.

This MOA recognizes that EPA and the Corps would likely have occasional disagreements as they have had historically, but also recognizes the Corps regulatory authority as the permit issuing agency under Section 404. Nevertheless, both agencies recognized the need for some cases to receive additional review at higher levels within each agency, in part to attempt to resolve cases without EPA exercising its 404(c) authorities. In this 404(q) MOA, both agencies agreed to limit elevations to cases where 1) permit applications involve "aquatic resources of national importance" (commonly referred to as ARNI cases), and 2) EPA believes that the authorized discharge(s) would result in unacceptable adverse impacts to those nationally important aquatic resources.[39]

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[38] As reported by EPA: "In 2005, 92,500 permit applications were received nationally by the Corps. Approximately 4,500 (4%) of the applications received by the Corps were categorized as requiring individual permits." February 25, 2011 letter from Nancy Stoner, Acting Assistant Administrator, to Alaska Senator Lisa A. Murkowski. 3 pages plus enclosure.

[39] For example, roughly 4,500 applications required individual Corps permits in 2005. Of these, EPA designated ARNI resources in 31 proposed permits (*i.e.*, less than 1% of all Public Notices), and initiated 404(q) resolution procedures in only one of these cases (subsequently resolved) -- February 25, 2011 letter from Nancy Stoner, Acting Assistant Administrator, to Alaska Senator Lisa A. Murkowski. 3 pages plus enclosure).

The MOA establishes procedures and timelines that must be followed if EPA intends to elevate a permit application for higher review within the Corps and EPA. The Corps retains the final authority on such cases insofar as permit issuance is concerned, but the MOA includes a 10-day Corps-to-EPA notice window for EPA to initiate action under its 404(c) authority if EPA believes that permit issuance might result in unacceptable environmental impacts. If EPA initiates action pursuant to Section 404(c), the Corps permit application is suspended until EPA's 404(c) process is completed or resolved.

It follows that EPA intends its 404(c) authority to be reserved for important cases that involve important aquatic resources. In fact, in 2002, EPA Headquarters clarified this in a memorandum to all of its Regional Administrators stating that "*regarding elevating decisions of specific individual permit cases, these cases must be limited to those matters that involve ARNI. Cases that do not meet this resource threshold may not be elevated under the* [404(q)] *MOA. According to the MOA, cases that would meet the resource threshold would be those cases that would cause resource damages similar in magnitude to cases evaluated under Section 404(c) of the CWA.*"[40]

As described in Section V.C.1. below, proposals to mine the Pebble ore deposit would cause the loss and/or degradation of thousands of acres of wetland and aquatic areas in the headwaters of the Upper Talarik Creek and Koktuli River drainages, as well as thousands of acres of associated upland habitat (acreage estimates made from Wardrop 2011 and 2006 water rights applications by Northern Dynasty Mines Inc.). Compared to the types and acreages of wetland and aquatic habitats that have been determined to constitute aquatic resources of national importance in the past, these headwater habitats in the Bristol Bay watershed should easily meet this ARNI threshold. Later in this report, these impacts are directly compared to other resources that EPA has determined to be aquatic resources of national importance, as well as the resources at stake in cases where EPA has initiated previous 404(c) procedures.

V. Evaluation of mining the Pebble deposit for compliance with the 404(b)(1) Guidelines

A. Compliance with the Guidelines: Alternatives

The Proposed Project

For the purposes of this analysis, the authors rely on Pebble Mine development scenarios described in Wardrop (2011) and 2006 Water Rights Applications made by Northern Dynasty Mines, Inc. (2006(a-f)), with the understanding that the ultimate mine design could differ considerably. The Preliminary Assessment of the Pebble Copper-Gold-Molybdenum Project or Wardrop report (2011) addresses three development phases: the 25-year, 45-year and 78-year scenarios. Of these, the 25-year scenario (2 billion tons of ore) offers the most advanced project planning to date, while the 78-year scenario (6.5 billion tons) offers an opportunity to evaluate

[40] January 2002 Memorandum from G. Tracy Mehan, III, EPA Assistant Administrator for Water, to EPA Regional Administrators. Subject: Designation of Aquatic Resources of National Importance under Clean Water Act Section 404(q) Memorandum of Agreement with the Army Corps of Engineers. 2 pages.

potential cumulative impacts as the most current, reliably delineated ore body is fully exploited. We note, however, that the 45-year scenario (3.8 billion tons) is considered the target project for investment consideration purposes (Wardrop 2011).

Northern Dynasty Minerals Ltd. (NDM)[41] has identified a total of 11.9 billion tons of potential ore reserves, 5.33 billion tons of which are "inferred," meaning there is less certainty it can be mined profitably (Wardrop, 2011). But as exploration continues, it is quite possible that the 78-year scenario (6.5 billion tons) could be exceeded (*i.e.*, mining could continue into the future or at an accelerated rate). As stated in Wardrop (2011, p. 6) "*This initial phase of mining* (*i.e.*, 25-year scenario) *would process...less than 20% of the total Pebble mineral resource.*"

For the purposes of this report, we will focus on the 25-year scenario and assume that direct and indirect impacts associated with the 45- and 78-year scenarios, up to full exploitation of the total Pebble resource, can be estimated in direct proportion to the amount of ore, and hence the amount of solid waste/fill that would be generated. To the extent that these assumptions are incorrect, our findings and conclusions may require revision.[42]

The Pebble Mine 25-year scenario

Mine site

Under this scenario, approximately 2 billion tons of ore would be mined, crushed and ground in semi-autogenous and ball mill grinders and processed in a froth-flotation mill at a rate of 229,000 tons of ore per day (Wardrop 2011). Copper concentrate and molybdenum concentrate would be produced in a "bulk rougher scavenger flotation" circuit that would also produce non-pyritic tailings. A pyrite separation flotation circuit and a gold leaching circuit would produce gold and "cleaner scavenger" pyritic tailings. The mine pit and adjacent waste rock disposal areas would disturb over 5200 acres (Figure 3).

A substantial portion of the areas where the mine pit and waste rock disposal areas are proposed contain wetlands, open water ponds, and tributary streams (Figure 4), including 2 or more miles of the main stem of Upper Talarik Creek, a documented Alaska anadromous water, and several additional miles of its tributaries, as well as several miles of tributaries to the South Fork Koktuli River, another documented Alaska anadromous water (Figure 1).

The mill would be northwest of the pit, along with a 378 MW natural-gas fired power plant and an 11-acre process water pond. Approximately 1.1 million tons of copper concentrate would be

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[41] "NDM" is used as an abbreviation for Northern Dynasty Minerals, Ltd. In applications for water rights in 2006, the company was called Northern Dynasty Mines, Inc., and no abbreviation is used in referencing that company in an effort to avoid confusing the reader.

[42] In reviewing the 2006 water rights applications by Northern Dynasty Mines, Inc., TSF's were proposed in Area G (unnamed tributary to the North Fork Koktuli River) and in Area A (South Fork Koktuli drainage, including Frying Pan Lake and associated streams and wetland areas). It is likely that the relative impacts to regulated waters of the United States would be greater within Area A than within Area G, and that the impacts per ton of disposed tailings would not be directly proportional. If there are other alternative disposal areas where impacts would be less than Area G, the expansion of mining beyond the initial 25-year phase might be proportionally less. The authors will revisit this issue if and when more specific information becomes available.

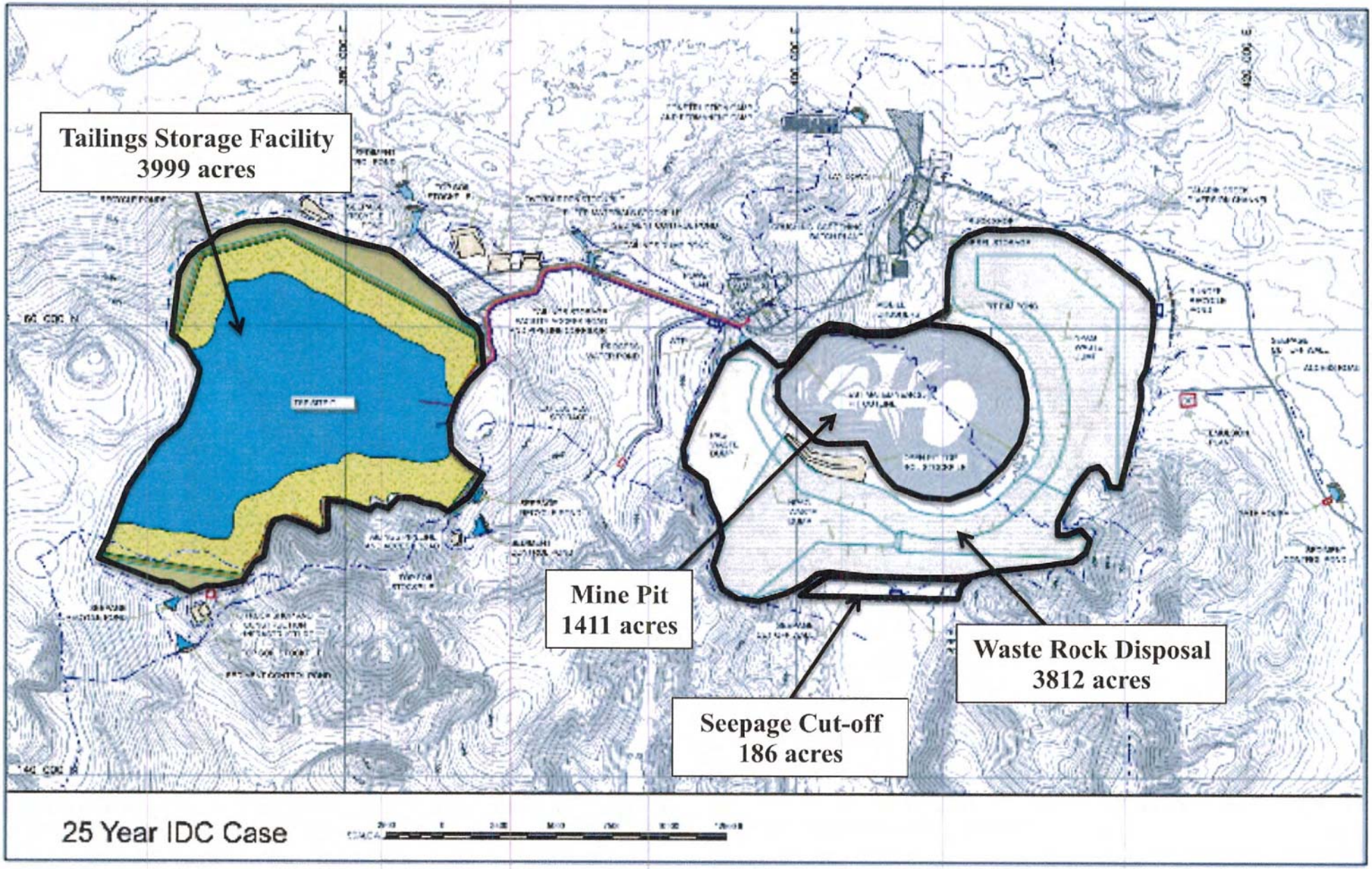
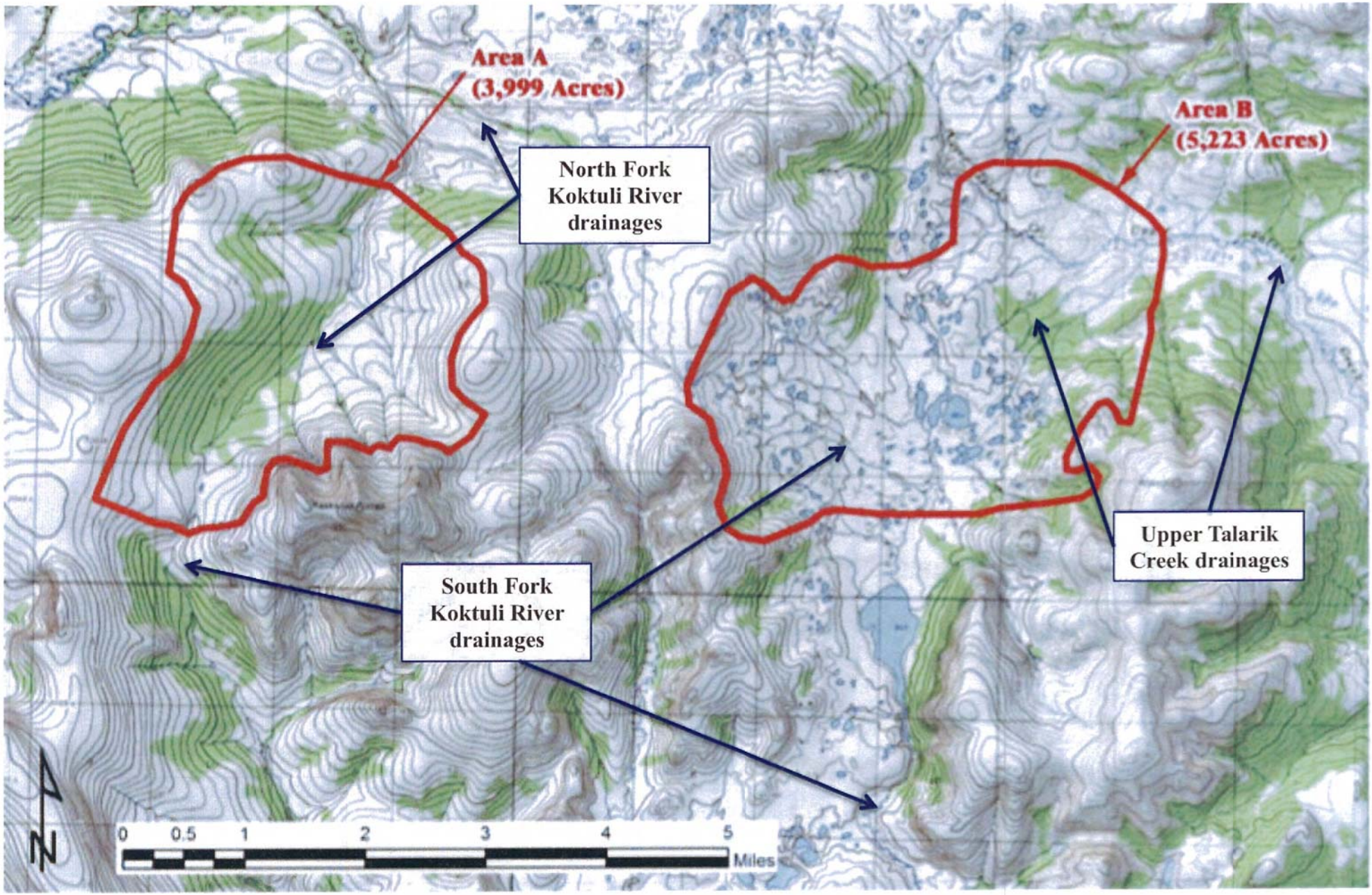


Figure 3. Approximate acreages of project features for the 25-year Pebble Project. Underlying figure from Wardrop (2011).

Figure 4: Areas proposed for tailings disposal (Area A) and an open pit mine with waste rock disposal (Area B) under a 25-year plan to mine the Pebble deposit (outlines from Wardrop 2011)



produced annually and would be transported to the port site in a slurry pipeline where it would be de-watered and stored prior to shipment (Wardrop 2011). Molybdenum sulfide concentrate would be bagged and trucked to the port site.

The approximately 4000-acre tailings storage impoundment in an unnamed tributary of the North Fork Koktuli River (Area G) would destroy several miles of documented anadromous fish habitat. The impoundment would be created by constructing three dams, including a 685-foot high, 3-mile-long dam that would impound that tributary and a small area of another unnamed tributary valley at the southern end of the impoundment in the South Fork Koktuli drainage (Figure 4).

Infrastructure

The project would include an 86-mile transportation corridor connecting the mine to a proposed port on Cook Inlet,[43] including an access road and four parallel pipelines for copper-gold concentrate, reclaim water, natural gas, and diesel fuel (Northern Dynasty Minerals Ltd. 2011). The concentrated ore would be transported to Cook Inlet, dewatered, and loaded on ships, and recovered water would be piped back to the mine site for storage and/or treatment. The road would cross approximately 120 streams (Northern Dynasty Mines Inc. 2005h).

Solid Waste Management

A tailings storage facility (TSF) at site G, approximately three miles west of the mine pit, would impound unnamed tributaries to the North Fork Koktuli River, and would fill an area of approximately 4000 acres[44] with 2.0 billion tons of mine tailings (Wardrop 2011, Figure 3). Approximately 85% of the tailings would be bulk rougher-scavenger non-pyritic tailings and 14% would be a combination of cleaner scavenger and gold plant pyritic tailings (the remaining 1% represents the portion of the ore shipped off as concentrate). This impoundment would be created by constructing a 685-foot high dam on the north side and two smaller dams on the south and southeast to prevent discharges to the South Fork Koktuli drainage. This TSF would destroy several miles of documented anadromous fish habitat, several additional miles of tributary streams, and thousands of acres of wildlife habitat (see Section V.C.1 below).

The main dam would be composed largely of overburden, non acid-generating (NAG) waste rock and glacial till with an impervious 80-mil high-density polyethylene (HDPE) liner and an internal drainage system and seepage cutoff wall (Wardrop 2011). Bulk non-pyritic tailings would be discharged via slurry pipeline to a series of spigots that would form a tailings "beach" with a supernatant pond in the center. Pyritic tailings that would be potentially acid generating would be discharged and stored under water in the supernatant pond to inhibit oxidation.

The impoundment would be unlined, except for the interior faces of the dams. A seepage collection pond and seepage collection/monitoring wells would be installed downstream of each tailings dam.

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[43] Four potential port sites have been evaluated at the northern end of Cook Inlet near Iliamna and Iniskin Bays (Northern Dynasty Mines Inc. 2005c. See also Figure 3).

[44] Estimate based on figure 18.3.2 from Wardrop 2011.

Unlined waste rock piles for non-acid generating (NAG) waste rock (2.34 billion tons) as well as potentially acid-generating (PAG) waste rock (0.63 billion tons) would be constructed on the east, south and west sides of the pit, covering an estimated 3800 acres (Wardrop 2011; Figure 3). At the end of mining, the PAG waste rock would be run through the mill and the tailings discharged to the mine pit.

Water Management

During construction, sediment control structures would be used to control sediment. During operation, the site G TSF would provide recycled process water to the process water pond adjacent to the mill. In addition to the tailings and associated mill process water that would be delivered to it as a slurry, the TSF would be engineered to store the Probable Maximum Flood as well as net precipitation, leachate/seepage from the TSF, mine pit water, and concentrate slurry return water and runoff from the port site on Cook Inlet (Wardrop 2011). Excess water would be discharged to a water treatment plant for subsequent discharge to the environment. At closure, the TSF would be reclaimed, with all water diverted to the mine pit and "*water levels would be maintained by treating inflow and discharging it as during operations*" (Wardrop 2011, p. 55).

1. Off-site Alternatives

The 404(b)(1) Guidelines require that no discharge of dredged or fill material into waters of the United States, including wetlands, be permitted if there is a less environmentally damaging practicable alternative (referred to as a LEDPA) to achieve the basic purpose of the proposed project. The basic purpose of mining the Pebble deposit is to extract copper and associated minerals (in this case gold, molybdenum, and other precious metals). As with other types of private development projects evaluated for compliance with the Guidelines, the assessment of "basic project purpose" is focused on the primary reason that a mineral deposit is being mined (Yocom et.al. 1991). The basic purpose of this project, as far as the consideration of potentially less environmentally damaging sources, is the extraction of copper and associated minerals; other copper deposits should be considered as alternatives under the regulations if they are practicable and less damaging environmentally. The fact that other copper deposits may have different associated metals that could be recovered than those found in the Pebble deposit should not eliminate their consideration under the Guidelines.

An alternative is "practicable" if "*it is available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes. If it is otherwise a practicable alternative, an area not presently owned by the applicant which could reasonably be obtained, utilized, expanded or managed in order to fulfill the basic purpose of the proposed activity may be considered.*"[45] (emphasis added). As stated earlier, where the discharge would be into a "special aquatic site" for a purpose that is not "water-dependent," the regulations presume that there is a less-damaging alternative, unless the permit applicant clearly demonstrates otherwise.

[45] See the 404(b)(1) Guidelines at 40 CFR 230.10(a)(2).

Applied to the basic purpose of extraction of copper and associated minerals, the proposed mining of the Pebble deposit would result in non-water-dependent discharges of fill material into "special aquatic sites,"[46] and the analysis of alternatives should include not only practicable means of avoiding or minimizing such discharges at or near the Pebble deposit, but also alternative locations where copper and associated minerals could be extracted with less potential environmental harm.

If it is practicable for the project sponsors to "obtain, utilize, expand, or manage" other copper ore deposits, then those deposits should be considered in determining the LEDPA.[47] Previously, mineral rights to the Pebble deposit were held by Cominco (now Teck), which explored the Pebble deposit from 1988 to 1997. These rights were sold to the Canadian firm, Northern Dynasty Mines, Inc. in 2001. In 2007, NDM entered into a partnership with England-based Anglo American (Northern Dynasty Minerals, Ltd. 2011). The Pebble deposit is only one of the copper deposits to which these partnership companies have had access.

For example, Anglo American has six on-going copper extraction operations underway in Chile, and two large proposed, but as yet unapproved, copper mining operations in Peru.[48] Anglo American lists the Pebble deposit as an additional copper mining proposal with partner NDM.

Similarly, Hunter Dickinson Inc. (Vancouver, BC), of which NDM is a subsidiary,[49] lists its other subsidiary firms as:

- Heatherdale Resources (pursuing six copper-gold-zinc-silver deposits on Alaska's Prince of Wales Island, and the Delta copper-lead-zinc-gold-silver project in east-central Alaska);
- Curis Resources LTD (which in 2010 acquired the existing Florence copper mine in central Arizona from previous owner BHP);
- Northcliff Resources LTD (seeking to develop a Tungsten-Molybdenum Project in central New Brunswick);
- Rathdowney Resources LTD (focused on finding and developing zinc deposits in Poland and Ireland);
- Taseko Mines Limited (controls the existing Gibraltar copper molybdenum mine in British Columbia,[50] and the proposed New Prosperity gold-copper mine at a neighboring deposit);

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[46] Based upon baseline descriptions of the surface of the Pebble deposit, as well as on-site observations of the authors, it is clear that mining the Pebble deposit would result in discharges of dredged or fill material into wetlands, riffle-and-pool complexes, and vegetated shallows.

[47] In its 404(c) action regarding the proposed Attleboro Mall in Massachusetts, EPA determined that alternatives that were available to the applicant when it entered the market for its project fall within the range of potentially practicable alternatives, even if those alternatives are no longer available at the time that the applicant actually applies for a permit. Inasmuch as the present project sponsors acquired mineral rights to the Pebble deposit in 2001, the consideration of less-damaging alternatives could include alternative copper deposits that were available as far back as 2001, if not earlier.

[48] http://www.angloamerican.com/aal/imap/ -
pageType=map/locn=all/industry=Copper/activity=all/filter=industry/lSelect=nothing

[49] http://www.hdimining.com -- Note that the President and CEO of Hunter Dickinson is also the President and CEO of NDM (Northern Dynasty Minerals Ltd. 2011).

[50] The Gibraltar mine in British Columbia has been cited by the Pebble Partnership as an example of hardrock mining being compatible with large salmon runs, but this mine is considerably smaller than that proposed at the

- Amarc Resources Limited (seeking to develop the Newton deposit in British Columbia, acquired in 2009 that contains gold, silver, copper and zinc); and
- Hunter Dickinson Inc. is also credited with developing the Golden Bear (gold, British Columbia), Mt. Milligan (copper-gold, British Columbia), and Kemess (copper-gold, British Columbia) mines,[51] though all are now owned by other mining companies.

Given that these mining companies have several alternatives that are presently under their control, and have demonstrated an ability to obtain, utilize, and manage other existing deposits and mining operations, it is appropriate that the environmental impacts of mining these and other alternative sites be considered as potentially less environmentally damaging alternatives that an applicant would have to clearly demonstrate are not practicable in achieving the basic purpose of extracting copper and associated minerals. It would also seem appropriate for EPA to consider the assets of the parent corporations, based on guidance it received from the Government Accounting Office regarding liabilities regarding hardrock mining cleanup obligations.[52]

In addition, there may be a significant number of copper deposits that could be "*obtained, utilized, expanded or managed*" by the project sponsors to achieve the basic purpose of extracting copper and associated minerals [see 40 CFR 230.10(a) regarding practicable alternatives that are not already owned or controlled by the permit applicant]. In fact, some copper deposits where mining was discontinued due to low copper prices (rather than declining mineralization) are being proposed for re-mining.[53] Such formerly mined sites are likely to have existing infrastructure, such as access roads and available power supplies that would tend to reduce start-up costs and increase potential practicability. And, almost by definition, previously mined deposits are sites where environmental resources have already been lost, disturbed, and/or degraded by mining-related activities. Accordingly, re-mining could result in far less additional environmental harm than that associated with a new mining operation in an undisturbed area, such as is being considered at the Pebble deposit.

2. On-site Alternatives

a. Tailings impoundments in other watersheds/locations

NDM reviewed some 30 alternative conceptual mine plans, including discharging tailings to Lake Iliamna (Wardrop 2011). In 2006, Northern Dynasty Mines, Inc. proposed discharging mine tailings to site A, south of the mine pit. This TSF would have required three tailings dams

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Pebble deposit, and although originally designed as a zero-discharge facility, has since June 2009 been permitted to discharge effluent directly into the Fraser River (http://www.cohencommission.ca/en/pdf/PPR/PPR15-Effluents.pdf).

[51] http://www.amarcresources.com/ahr/Home.asp

[52] "*Finally, financial assurances for businesses at risk for environmental contamination can help mitigate the fact that businesses can legally organize or restructure in ways that can limit their future expenditures for cleanups by, for example, separating their assets from their liabilities using subsidiaries to protect their assets*" (United States Government Accounting Office 2006). Furthermore, England-based Rio Tinto is also invested in the proposed Pebble Project, and it has alternative copper ore holdings, including the Bingham Mine in Utah, presently the largest open pit mine in North America.

[53] One such example is at the former Anaconda open pit mine near Yerington, Nevada, where some estimates suggest that the mineral deposits, including the Bear deposit, may yield as much as 50 billion pounds of copper. See: http://www.quaterra.com/projects/sps_yerington_copper/project_description/

totaling 15,300 feet in length, approximately 700 feet, 710 feet and 740 feet high and covering an area of 4200 acres. With capacity for 2 billion tons of mine tailings, it would have completely buried Frying Pan Lake. This site, as well as tailings disposal in Iliamna Lake, have apparently been dropped from further consideration at this time.

It is very difficult at this stage of the project planning to determine if there are feasible, less damaging alternative sites for tailings storage facilities or waste rock piles within a reasonable distance of the mine pit. Most streams, if not all, within the general project area support anadromous fishes.

b. Lined tailings impoundment(s)

This is an on-site alternative that has not been proposed by NDM. It would only be required if testing of mine wastes demonstrates that they are not suitable as fill material (*i.e.*, exhibit toxicity). For the purposes of this report, lined tailings and other means to segregate mine wastes from the aquatic environment will be addressed under Mitigation (Section V.D. below).

It should be noted that for lined tailings impoundments or lined dry-stacked tailings facilities proposed in waters of the United States, the project proponent must apply for a CWA 404 permit for placement of the liner. If the permit is approved, tailings or waste rock are then placed on top of the liner, after waters of the United States have been removed from jurisdiction via the CWA 404 permit for the liner. Examples of this approach include the Pogo gold mine in Alaska and the Grouse Creek gold mine in Idaho.

B. Compliance with the Guidelines: Water Quality and Endangered Species Act

1. Water quality compliance

It is quite clear that the Pebble deposit is in a net precipitation area, and that discharges from the tailings impoundments, waste rock disposal areas, and mine pit will occur over time. These discharges would be required to meet National Pollutant Discharge Elimination System (NPDES) effluent limits at all times to assure that State of Alaska Water Quality Criteria (WQC) protective of aquatic life are met throughout the life of the project and well beyond.

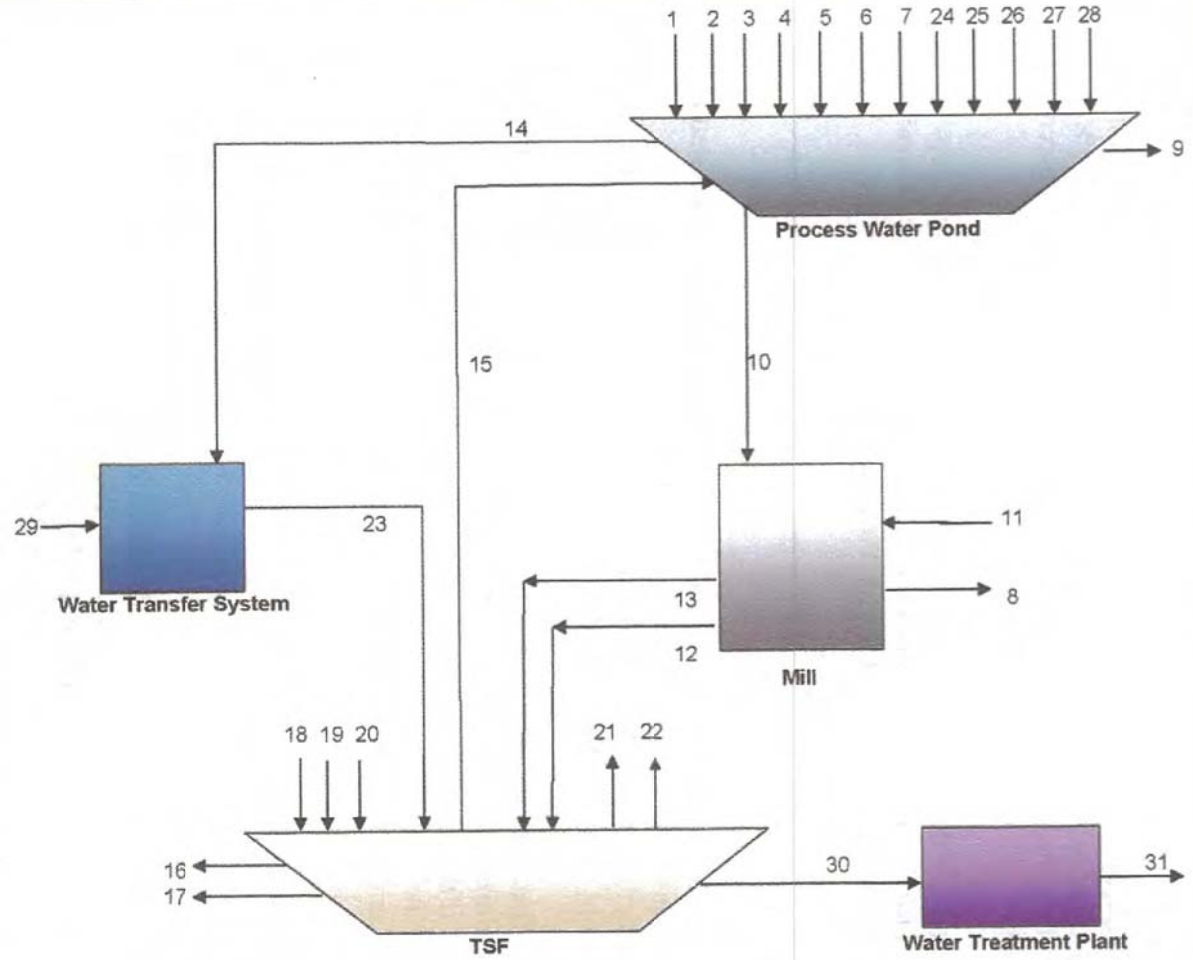
Quantity of Wastewater to be Treated

At present no quantitative water balance has been developed (or at least made public) for proposals to mine the Pebble deposit. A conceptual water balance flow diagram is provided in Wardrop 2011 (Figure 5). Although the diagram shows mine pit water and waste dump runoff flowing to the 11-acre process water pond, excess water would be directed to the much larger TSF via the Water Transfer System. Excess water would then flow from the TSF to the water treatment plant (WTP) prior to discharge to the environment.

EPA's New Source Performance Standards (NSPS) for NPDES wastewater discharge permits for mines utilizing froth flotation mills like Pebble prohibit discharges of "process wastewater" but allow permittees to discharge "net precipitation" falling on tailings impoundments as well as mine drainage (40 CFR 440 subpart J). Recycling of tailings supernatant water to the mill,

Figure 18.3.6 Water Balance Flows

Number	Description
1	Undiverted Mine Site Runoff
2	Waste Dump Runoff
3	Open Pit Runoff
4	Additional Open Pit Snow (snowblow)
5	Underground Runoff
6	Additional Underground Snow (snowblow)
7	Recycle Concentrate Water
8	Concentrate Water
9	Demin Plant Water
10	Process Water Pond to Mill
11	Ore Water
12	Bulk Tailings Water
13	Pyritic Tailings Water
14	Excess Water from the Mill
15	Makeup Process Water from TSF
16	Water Retained in Bulk Tailings Voids
17	Water Retained in Pyritic Tailings Voids
18	Seepage Collection Ponds Runoff
19	Undiverted TSF Runoff
20	Direct Precipitation
21	Evaporation
22	Sublimation
23	Water Transfer System to TSF
24	Groundwater from Open Pit Upper Benches
25	Groundwater from Open Pit Lower Benches
26	Groundwater from Underground
27	Open Pit Advanced Dewatering
28	Underground Advanced Dewatering
29	Port Site Runoff
30	TSF to Water Treatment Plant
31	Water Treatment Plant to Environment



EPA-6363-000007786

Figure 5. Water balance inputs and outputs for proposed 25-year Pebble mining proposal. (reproduced from Wardrop 2011 – Figure 18.3.6)

equivalent to all process water discharges to the impoundment (*i.e.*, 100% recycle), is required during operation. Runoff from waste rock piles is treated as storm water but it, too, must meet applicable WQC prior to discharge to waters of the United States. Mine pit water and underground mine drainage that is discharged to waters of the United States must meet WQC as well as EPA's NSPS effluent limits (no recycle required).

The site G TSF described in Wardrop 2011 would cover approximately 4000 acres. Annual precipitation at the TSF is approximately 41.7 inches, mean annual lake evaporation is estimated at 7 inches, and mean annual sublimation (direct evaporation of snow) is estimated to be 4 inches water equivalent (Wardrop 2011, p. 350). Annual net precipitation at the site G TSF is therefore approximately 30.7 inches. Using a conservative figure of 30 inches of net precipitation and assuming 100% diversion of runoff from the surrounding catchment area, which is optimistic, an allowable discharge of runoff and seepage from the site G TSF would be roughly 10,000 acre-feet. This is equivalent to 3.26 billion gallons per year, 8.9 million gallons per day (MGD) or a flow of 13.8 cubic feet per second (CFS) as a waste stream requiring treatment prior to discharge.

In addition to net precipitation, mine drainage (*i.e.*, water pumped from the open pit and underground workings) is estimated at 11.7 MGD (derived from Wardrop, 2011, tables 18.3.2 and 18.3.3). Runoff from waste rock disposal areas, which cover approximately 3800 acres under the 25-year scenario (Figure 3), could contribute another 9500 acre-feet at 30 inches net annual precipitation. Assuming one third of the waste rock runoff infiltrates and is captured in the mine pit water, waste rock runoff diverted to the TSF under the 25-year scenario could be as high as 5.7 MGD. Ignoring the contribution of water reclaimed from the ore concentrate slurry and port site runoff that would be piped back to the mine from the Cook Inlet port site, total wastewater treatment requirements in terms of volume/flow for the 25-year scenario could exceed 26 MGD.

The 25-year plan represents less than 20% of the entire (measured, indicated and inferred) ore body of 11.9 billion tons (according to present estimates). If one assumes that tailings storage capacity, mine pit de-watering and waste rock dumps increase proportionately to the quantity of ore that is mined, then runoff/net precipitation from multiple tailings impoundments could exceed 44.5 MGD (16.3 billion gallons per year or 69 CFS). Mine pit water under full pit and underground mine exploitation could be as high as 58.5 MGD. Likewise, waste rock runoff could be as high as 28.5 MGD for a potential total volume of wastewater needing treatment prior to discharge of greater than 150 MGD (see Table 1).

To put this in perspective, the City of Anchorage wastewater treatment plant, the largest in the state, has a design average daily capacity of 58 MGD; it discharges to Cook Inlet (EPA, 1999, Fact Sheet, John M. Asplund Wastewater Treatment Facility NPDES Permit Number: AK-002255-1). Mining the Pebble deposit, as presently envisioned, would discharge to three relatively small headwater streams, all of which provide wild salmon spawning and rearing.

Water Quality

Discharges of this magnitude into receiving waters would most likely constitute the majority of stream flow during the dry seasons, if not year round, especially considering groundwater withdrawals and their drawdown effects. Since the receiving waters are very low in hardness

Table 1. Pebble Production Rate and Discharge Parameters Compared to Other Alaska Mines

MINE	Target minerals[1]	Ore processing rate (tons per day)	Tailings Facilities (acres)	Allowable discharge rate (millions of gallons per day)	Copper MDL/AML[2] (parts per billion)	Mixing zone?
Greens Creek	Ag, Pb, Zn, Au	2400	123	1.1	300/150	yes
Red Dog	Zn, Pb	9000	585	6.6	25.2/12.6	yes
Ft. Knox	Au	49,000 [3]	1,150	N/A	N/A	N/A[4]
Pogo	Au	3500	108	0.86	4.4/2.2	yes[5]
Kensington	Au	2000	55	N/A	3.7/1.9	yes[6]
Pebble 25-year (2 Billion Tons)	Cu, Au, Mo	218,000	4,000	26.3	2.8/1.4[7]	no
Pebble 45-yr (3.8 Billion Tons)	Cu, Au, Mo	229,000	7,600	50	2.8/1.4	no
Pebble 78-yr (6.5 Billion Tons)	Cu, Au, Mo	229,000	13,000	85.5	2.8/1.4	no
Pebble Full production (11.9 Billion Tons)	Cu, Au, Mo	229,000	23,800 (37.2 square miles)	156.5	2.8/1.4	no

[1] Ag = silver; Au = Gold; Cu = copper; Mo = molybdenum; Pb = lead; and Zn = zinc
[2] Maximum daily limit/average monthly limit
[3] Includes 10,000 tons per day from the True North pit
[4] Zero-discharge project
[5] Off-river mixing pond in lieu of in-river mixing zone (25:1 ratio)
[6] Dilution occurs in Slate Lake, NPDES compliance point at lake discharge to Lower Slate Creek
[7] From Ecology and Environment, Inc. 2010

and dissolved organic carbon, the applicable water quality criteria for copper and other metals, which are based on, and proportional to, hardness, would also be very low. In other words, it would be a very small target, approximately 2.85 ppb for copper at a hardness of 25 ppm (Ecology and Environment 2010). As the receiving waters are all anadromous streams, no mixing zones could be authorized, according to Alaska's EPA-approved Water Quality Standards, so WQC would have to be met end-of-pipe (18 ACC 70 Water Quality Standards May 26, 2011).

Wardrop (2011) describes the proposed water treatment plant (WTP) as utilizing a combination of chemical addition, clarification, and filtration to meet WQC and effluent limits. After year five, a reverse osmosis system would be added to remove sulfates and Total Dissolved Solids (TDS). High TDS levels have been shown to have a deleterious effect on egg development of certain species of fish, including salmonids (Weber-Scannell and Duffy 2007). The capacity of the WTP would be increased using modular units to match the increasing volume of contaminated water requiring treatment.

The ability of the WTP to successfully treat to regulatory levels all contaminated mine site wastewater (from the TSF, waste rock disposal areas, and mine pit) hinges largely on the ability to capture all contaminated water sources and successfully convey this water to the TSF and then to the WTP (assuming the WTP has the capacity to treat all wastewater to meet WQC). As described in Wardrop (2011, p. 350), the site G TSF area "*typically comprises sand and gravel with varying amounts of silt, and varies in depth from near surface to approximately 65 feet...Overburden at the higher elevations is mainly colluvium and glacial drift material consisting of sand and gravel with varying amounts of silt...The bedrock is typically highly weathered and frost-heaved near surface, becoming more competent with depth...The groundwater conditions observed at site G include artesian flows and groundwater levels generally near the surface.*" In short, the site is highly permeable as well as highly saturated and there can be no assurance that the proposed seepage cutoff walls and seepage capture ponds will be effective in capturing all water that migrates through the tailings. NDM apparently intends to rely on the bulk tailings, which are described as "*uniformly graded, consisting of sand and silt-sized particles*" to seal the tailings pond (Wardrop 2011, p. 353). Over time, however, it seems likely that contaminated water (leachate) would seep through the tailings and enter the highly permeable groundwater system that provides base flow to local streams.

In addition to capturing seepage/leachate and managing net precipitation that contacts the tailings, diversion ditches surrounding the TSF would need to be constructed to minimize runoff into the TSF and hence minimize the volume of additional water that would require treatment. As stated above, the calculation of net precipitation falling on the TSF assumes 100% diversion of runoff from the surrounding hillsides. This may prove to be quite a challenge given the steepness of the hillsides to the east and south of the TSF. Proper sizing of diversion structures to convey peak storm runoff and snowmelt is critical to the long-term stability of the tailings embankments and to prevent tailings from eroding. Long-term maintenance must be guaranteed.

It is not feasible at this time to predict with any degree of accuracy the chemistry of water within the TSF. However, humidity cell tests have shown that the cleaner tailings, approximately 14% of all tailings, continue to leach copper after 600 days (SRK Consulting, Inc. 2006; see

discussion under Section V.C.3. -- Significant Degradation -- below). And, if the entire ore body was mined, at estimated recovery rates of 85 to 88%, the tailings would contain over billions of pounds of copper.

No geochemical analyses are available for the pyritic tailings from the gold leach circuit, but they are presumed to be acid generating and as such are likely to leach metals. It is also not clear if cyanide would be used in the gold leach circuit, but cyanide leaching of gold is a fairly standard industry practice. The tailings will also contain at least trace amounts of reagents, such as xanthates, fuel oil (Wardrop 2011), and potentially residual cyanide.

In addition to net precipitation and mill process water that is discharged to the TSF as part of the tailings slurry, the TSF will receive waste dump runoff and mine pit water as described above under water quantity. Pre-tertiary waste rock has the potential to generate acid (SRK Consulting Inc. 2008), and subaqueous column tests of pre-tertiary waste rock indicate it has the potential to leach copper and other metals (SRK Consulting Inc. 2006). This is discussed further in Section V.C. -- Significant Degradation.

The waste rock disposal areas would be within the cone of depression of the mine pit, which would be continually de-watered during active mining. Seepage cutoff walls would be designed to inhibit the lateral migration of seepage/leachate from the waste piles. Mine pit water would also include runoff from mineralized pit walls that have been exposed to oxygen, and could potentially be acidic and/or contaminated with metals.

At closure, "*all site surplus water will be routed to the pit until such time that the water reaches the specified maximum post-closure water level that still maintains groundwater inflow conditions. Thereafter, the water will be pumped to a water treatment plant for treatment and discharge until such time as the water can be released without treatment*" (Wardrop 2011, p. 366). Although the "maximum post-closure water level" is not defined, the pit lake water could potentially intersect the local groundwater aquifers that provide base flow to Upper Talarik Creek. The mine pit water would now be subject to contamination from the PAG waste rock tailings and exposed sidewalls, as well as remaining mill process water from the reclaimed TSF and all other "site surplus water." No time frame is provided regarding how long pit water would need to be treated before contaminant levels attenuate to a point where WQC are met without treatment nor is the volume/flow of contaminated pit water needing to be treated quantified. Given the large quantities of wastewater that would be generated (see Table 1) along with the acid-generating nature of waste rocks and the copper-leaching potential of both waste rock piles and tailings, this could be a very long time.

No details are provided in Wardrop regarding the TSF reclamation plans. However, the TSF would continue to have a positive water balance due to the 30+ inches of net annual precipitation. Given the acid-generating nature of the pyritic tailings within the TSF, it is assumed that the project proponent would want to maintain saturated conditions within that part of the TSF where pyritic tailings are stored to inhibit oxidation and increased metals leaching. This would likely result in a permanent body of open water within the TSF, or within multiple TSF's given the need for additional tailings storage capacity over time. These permanent tailings pond "lakes" (or perhaps wetlands) would be considered waters of the United States and as such would be

required to meet WQC. No details are provided as to how this could be achieved. But like the pit lake, runoff (and pumped back seepage/leachate) from each TSF, whose cumulative surface area could exceed 20 square miles (see Table 1), treatment would likely be required until such time as contaminant levels attenuate to a point where WQC are met. Like the pit lake, this could be a very long time.

In summary, it cannot be determined definitively at this time if wastewater discharges from mining the Pebble deposit would or would not meet WQC at all times throughout the life of the project and beyond closure. The chemistry of water in the TSF cannot be reliably determined at this time nor can the pit water. However, the challenges to reaching this objective are significant and include:

- the extremely large volumes of wastewater that would need treatment (tailings pond runoff and seepage/leachate, the seepage and drainage from waste rock piles, and mine pit water; see Table 1);
- the potentially acid-generating nature of the pre-tertiary waste rock;
- the potential for pre-tertiary waste rock and pyritic tailings to continue to leach copper over time;
- the acid-generating nature of the pyritic tailings;
- the very low projected effluent limits for copper and other metals;
- the lack of any authorized mixing zones in the receiving waters;
- the high permeability of the materials underlying the TSF and waste rock piles that would make capturing seepage/leachate problematic, absent an engineered liner system;
- the need to construct and maintain many miles of appropriately sized diversion structures throughout the life of the mine and well beyond; and
- the indeterminable length of time contaminated water treatment may be needed.

Endangered species compliance

One of the facilities proposed for mining the Pebble deposit is a deep-water Port to which a slurry of concentrated copper and gold ore would be piped, dewatered, and loaded on ships for transport, and from which reclaimed water, diesel fuel, and natural gas would be piped to the mine and power plant sites. Four sites have been evaluated in studies performed by the project sponsor (Northern Dynasty Mines Inc. 2006d), and all are within designated critical habitat for the Cook Inlet beluga whale (Figure 6). This species was not evaluated in Northern Dynasty Mines' 2004 marine habitat baseline studies (Northern Dynasty Mines Inc. 2005d), but potential threats from port development and operations include habitat loss, potential for spills, and noise.

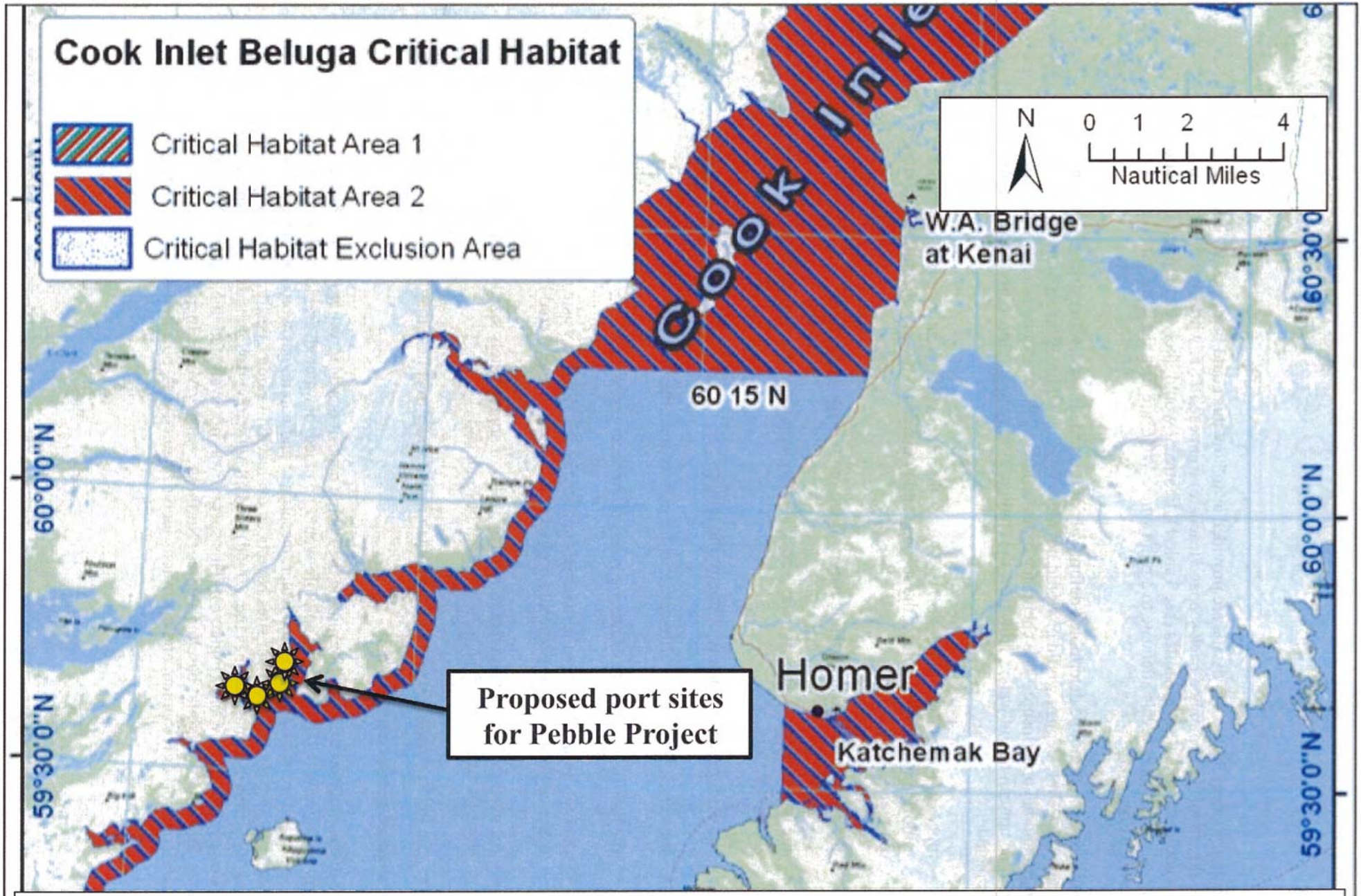


Figure 6: Sites proposed for a potential deep-water port for the Pebble Project compared with critical habitat designation for the endangered Cook Inlet beluga whale. Map by NOAA Fisheries. Proposed port sites estimated from Marine baseline studies (Northern Dynasty Mines Inc. 2005d).

It is the responsibility of the National Marine Fisheries Service (NMFS) to make determinations of whether a proposed project would or would not jeopardize the continued existence of Cook Inlet beluga whales. If development of a port within the whales' critical habitat was proposed for permitting, the Corps would need to initiate consultation with NMFS pursuant to Section 7 of the Endangered Species Act in order for this determination to be made, as well as for NMFS to propose reasonable and prudent measures that would be required in order to avoid jeopardy.

C. Compliance with the Guidelines: Significant degradation

No discharge can be permitted under Section 404 if it would cause or contribute to significant degradation of the waters of the United States, including wetlands. Mining the Pebble deposit would result in the permanent direct losses of extensive areas of waters of the United States, including special aquatic sites that are habitats for fish and wildlife. These losses would occur in at least three separate drainages that are tributary to Bristol Bay. These discharges also pose short- and long-term threats to downstream areas, chemically and hydrologically, and pose risks to fish and wildlife subsistence and recreational uses. Such impacts should be considered significant degradation under the Guidelines [40 CFR 230.10(c)]. Furthermore, the regulations state that secondary impacts that result from the discharge of dredged or fill materials should be considered in determining if the project would cause or contribute to significant degradation [40 CFR 230.10(h)]. The direct and indirect impacts that would cause or contribute to significant degradation are discussed separately below.

1. Significant degradation through direct losses of "waters of the United States"

Although no formal determination of the geographic extent of waters of the United States, including wetlands,[54] has been made by the Corps or EPA for areas within the proposed Pebble mine, the project sponsor indicates that it has sponsored several studies of the potential reach and extent of regulated waters at the project site. However, these studies, which were initiated in April 2004[55] have not been made public and, according to the project sponsor, cover a study area of approximately 104,000 acres. Furthermore, in its progress report for its 2004 wetlands studies, NDM reported that its wetland delineation teams collected data at a "specified rate of one jurisdictional determination plot per 100 acres of study area" (Northern Dynasty Mines Inc. 2005b). Such a rate is insufficient for most wetland delineation efforts, and a final determination of jurisdiction would require substantial field verification.

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[54] Waters of the United States are defined in federal regulations at 40 CFR 230.3(s)(1-7), and include tidal waters, tributary rivers and streams, lakes, adjacent wetlands, and "other waters."

[55] Determinations of Clean Water Act jurisdiction pursuant to Section 404 of the Clean Water Act can only be made by the Corps of Engineers or EPA, although "delineations" can be made by anyone trained in the use of the Corps' 1987 Wetlands Manual (Environmental Laboratory 1987). Determinations of jurisdiction are based on "normal circumstances" for the delineated area, and wetland jurisdictional "determinations" made by the Corps or EPA are typically based on recent on-site observations of hydrophytic vegetation, hydric soils, and wetland hydrology indicators. Inasmuch as determinations of jurisdiction expire after 5 years pursuant to Corps Regulatory Guidance Letter 05-20 (June 14, 2005), in order to be acceptable to the Corps or EPA, data collected early in NDM's wetlands studies will need to be shown to be representative of the site conditions that exist at the time that the project sponsor seeks a formal determination of jurisdiction.

For the purposes of this report, the size and location of proposed project facilities are taken from NDM's 2006 water rights applications to the State of Alaska, and the NDM's 2011 Preliminary Assessment of the Pebble Project (Wardrop 2011). From a 404 perspective, these documents vary primarily in the number and location of tailings impoundments. The size and location of the proposed mine pit are tied to the ore deposit and are similar in NDM's various documents.

Whereas these documents describe projects designed to operate for as few as 25 years, it is clear that mining the Pebble deposit would extend beyond, and have significantly larger direct impacts than, a 25-year project. Accordingly, it is appropriate, pursuant to the National Environmental Policy Act (NEPA) for EPA to consider not only what might be proposed as an initial phase of mining the Pebble deposit, but all reasonably foreseeable related actions, particularly expansion of those mining activities.

The pit and associated facilities were described in 2006 as covering an area of roughly 2 square miles (Northern Dynasty Mines Inc. 2006f), but more recently, a 25-year proposal described by Wardrop (2011) show a pit with a surface area of over 1400 acres, and adjacent waste rock disposal and seepage collection areas that cover more than 3800 additional acres (Figure 3). Similarly, the NDM 2006 water rights application proposed a TSF at Area G (unnamed tributary to the North Fork Koktuli River) that showed a surface area of 2300 acres and maximum depth of 450 feet (Knight Piesold Ltd. 2006b), but more recently, the proposal for this TSF has been significantly enlarged, with a surface area of nearly 4000 acres[56] and a maximum depth of nearly 700 feet (Wardrop 2011). Given the slopes of the drainages that would be filled beneath this TSF, the actual acreage of habitat that would be lost is considerably larger.[57]

Combining these estimates, mining the Pebble deposit, even at the smallest proposed project life (25 years) described in the 2011 preliminary assessment (Wardrop 2011), would destroy over 9200 of acres of habitat, including wetlands, open water areas, and streams (Figure 4), not including acreages associated with the power plant, mill site, camp compound, stockpile areas, detention basins, seepage collection areas, roads, and other features, and not including habitat losses or degradation associated with the 86-mile road to Cook Inlet, port facilities and operations, or pipeline installations and operations.

The actual reach of anadromous streams that would be directly lost is not known, nor is the full reach and extent of the streams utilized by anadromous species. For example, in its 2006 surface water right application for the North Fork Koktuli River, the project sponsor estimated that approximately 3.5 miles of tributary stream 1.190 would be buried under its proposed site G TSF; this tributary supports grayling, Dolly Varden, and coho and Chinook salmon. The source

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[56] A GIS specialist with Huffman-Broadway Group (HBG) estimated acreages from project features shown in Figure 18.3.2 (Final Site Arrangement – 25-year IDC Case) on page 357 of Wardrop (2011). HBG estimated acreages using coordinates within the underlying map in that figure which is in the Alaska State Plane V coordinate system.

[57] Northern Dynasty Mines' 2006 water rights applications proposed a second TSF at Area A (South Fork Koktuli drainage) that would have covered 4200 acres of wetland, aquatic and upland habitats to a maximum depth of 710 feet (Knight Piesold Ltd. 2006a). Assuming that mining the Pebble deposit would extend well beyond the minimum 25-year initial phase, such impacts would be additive to those proposed in the 25-year proposal and, again, the actual acreage of the habitats within the drainage that would be covered by this proposed TSF would be considerably larger than the estimated 4200-acre surface area at the crest of that Area A TSF proposal.

for this 3.5-mile estimate is not known, but if it is intended to represent the reach and extent of regulated "waters of the United States," it is likely significantly underestimated. Figure 7 shows streams within Tributary 1.190 that have been proposed to be impounded as a tailings storage facility at "Area G." The map on the left of this figure shows where the U.S. Geological Survey mapped several reaches of streams (shown as solid blue lines) within this stream drainage – there are over 8 miles of blue-line streams mapped within the approximate boundary of the proposed tailings impoundment.

Often, U.S. Geological Survey (USGS) blue-line streams are determined to be jurisdictional waters of the United States. However, USGS maps often are not mapped at a scale that shows smaller tributaries that may, nonetheless, be regulated streams. Figure 7 includes a detailed figure that accompanied Northern Dynasty Mines' application for surface water rights to the Area G drainage for a tailings storage impoundment (Northern Dynasty Mines Inc. 2006a). This map shows several additional stream channels that would be considered jurisdictional tributaries if they flow seasonally, intermittently, or even ephemerally, because they are tributary to traditionally navigable waters;[58] there are over 18 miles of mapped stream channels represented. Similarly, water rights were sought in 2006 for the headwaters of Upper Talarik Creek as well as tributaries and associated wetlands and ponds that overlie the Pebble deposit. These waters were proposed for removal by mining, and their water appropriated for mine use.

Portions of these tributary waters are listed in the Alaska Department of Natural Resources Anadromous Waters Catalog (AWC – see Figure 2). It is important to note that the AWC is a living document, and is continually being updated to reflect new, documented evidence (Alaska Department of Fish and Game 2011). Figure 8 shows a comparison between anadromous waters in the vicinity of the Pebble deposit in 2009 and those mapped in 2010. To some extent, the reach and extent of such waters is related to whether they have actually been visited and sampled.[59] As such, any estimates of the number of anadromous stream miles that would be directly or indirectly affected by mining the Pebble deposit are likely conservative. Figure 7 is an example of the degree to which stream mapping scale alone may affect the estimates.

In the absence of a verified on-site determination of the reach and extent of waters of the United States at the Pebble deposit and in surrounding drainages, it is impossible to quantify an estimate of the direct losses of waters, including wetlands that could result from mining the Pebble deposit. It is likely that much of the surface overlying the Pebble deposit, including the proposed pit and surrounding waste rock dumps (Wardrop 2011, page 357) contains special aquatic sites, including wetlands and vegetated shallows.

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[58] These streams are unlikely to be subject to regulatory disclaimer under the SWANCC (Solid Waste Agency of Northern Cook County (SWANCC) v. U.S. Army Corps of Engineers, 531 U.S. 159 (2001) or Rapanos (consolidated ruling for Rapanos v. United States and Carabell v. United States (126 S. Ct. 2208 (2006)) decisions of the U.S. Supreme Court regarding isolated or non-tributary waters.

[59] Given the size and geographic extensiveness of anadromous habitat in the Bristol Bay watershed, it might be more appropriate from a resource protection standpoint, for the Anadromous Waters Catalogue to presume anadromous waters are present unless site-specific sampling efforts have proven otherwise. Such a policy would mirror the Guidelines' presumption that a less-damaging alternatives to filling special aquatic sites "is" available unless clearly demonstrated otherwise by a permit applicant.

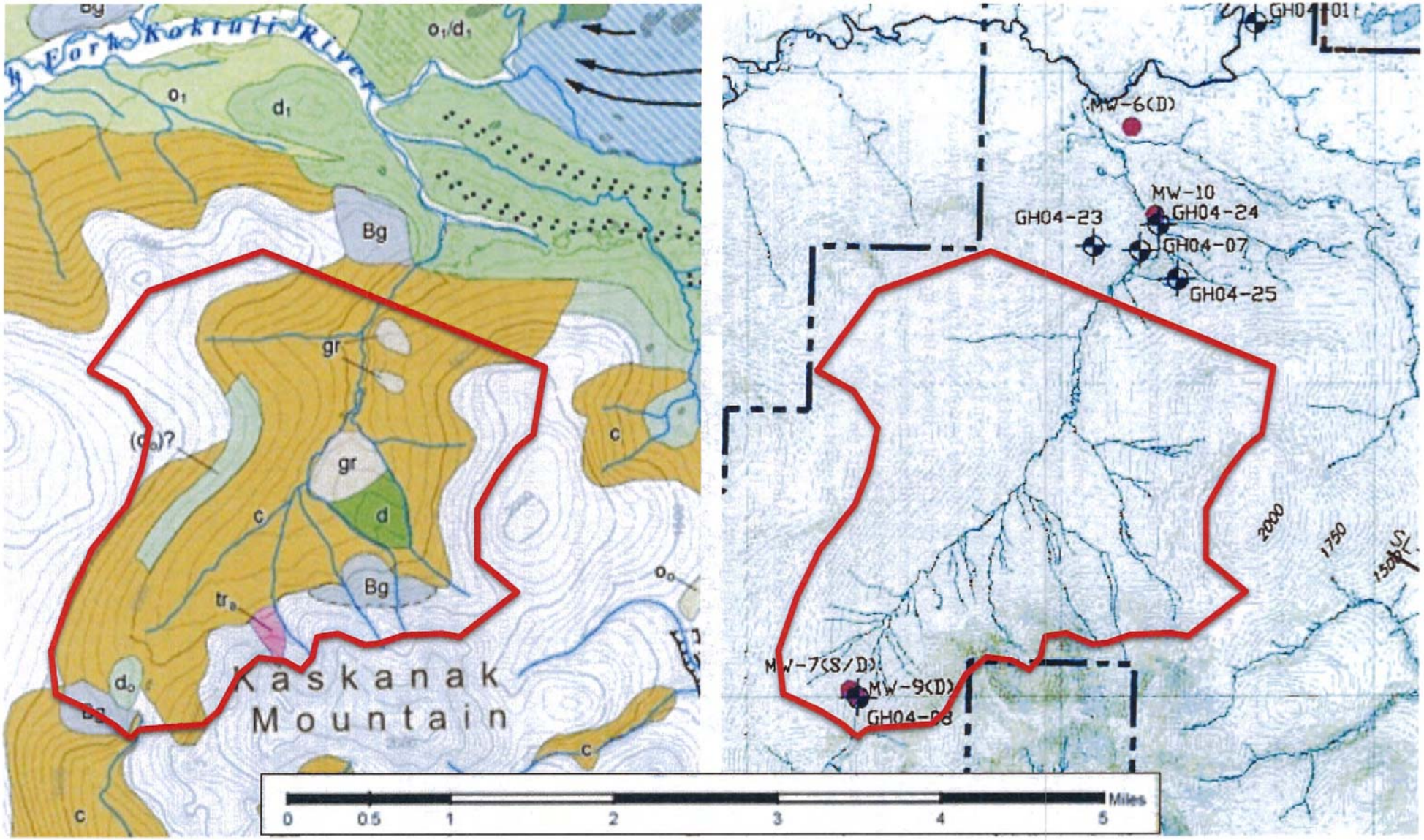

Figure 7: Comparison of USGS blue-line streams, as depicted on a surficial geology map of PLP's Pebble Project (Hamilton 2007) and streams channels in the same drainage in a 2006 Northern Dynasty Mines water rights application. This outlined drainage, a tributary of the North Fork Koktuli River, has been proposed as a tailings storage facility (Wardrop 2011).

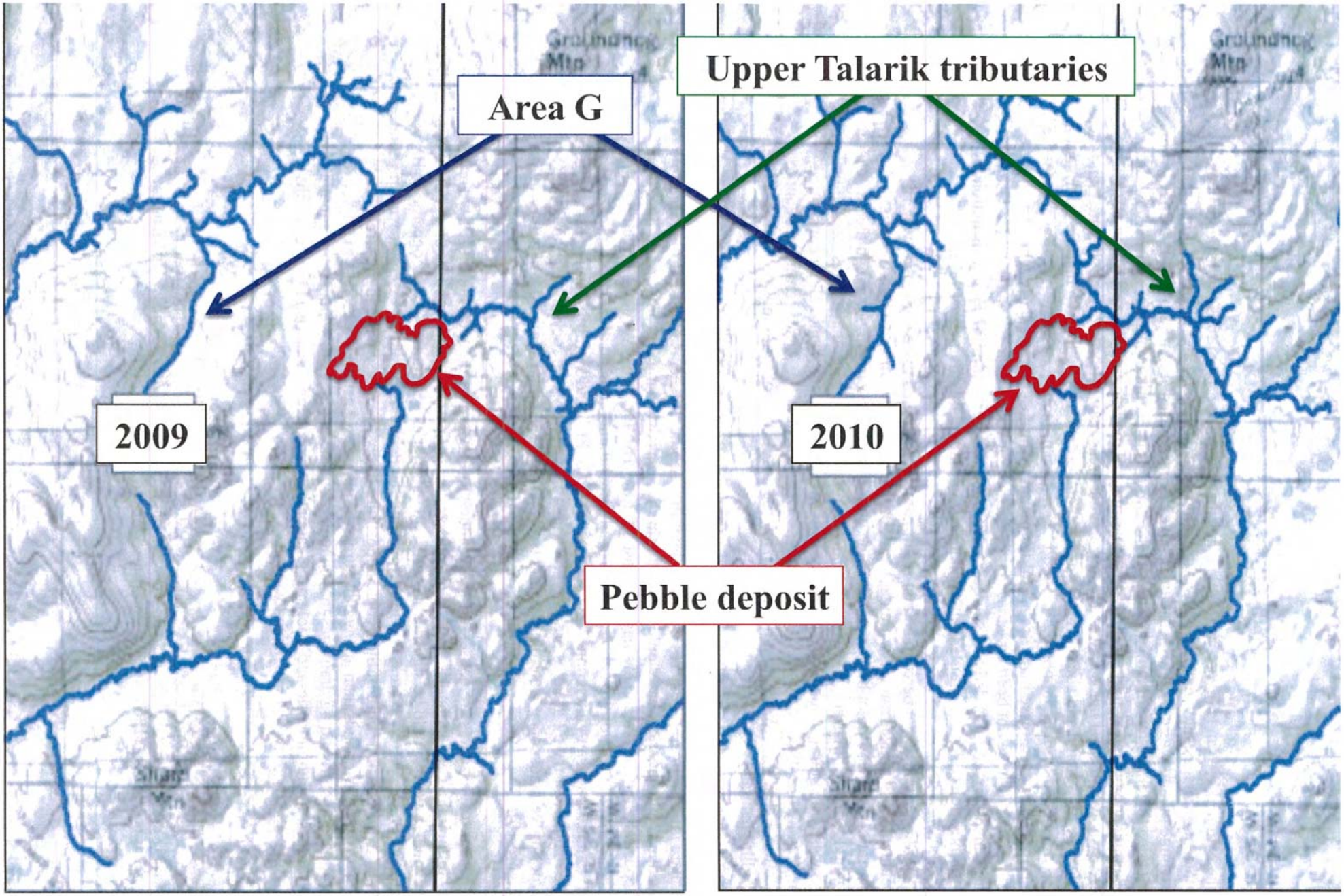

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Figure 8: Changes in Anadromous Waters Catalog between 2009 and 2010

The National Wetlands Inventory (NWI) maps that cover the area of the Pebble deposit and adjacent drainages show extensive areas of wetlands and deeper water habitats in the areas where the mine pit and waste rock disposal areas have been proposed (Figure 9). These maps are not intended to delimit jurisdictional waters of the United States, including wetlands. They are a planning and inventory tool for the U.S. Department of the Interior (Cowardin et.al. 1979). Areas shown on NWI maps as wetland and aquatic areas may be incorrectly delineated, and there also may be wetland and aquatic areas present that were not mapped, given that the information was developed from aerial photographs and has not been, in most cases, verified by any on-site surveys. However, these maps are useful for planning purposes, particularly when on-site investigations have not been, or cannot be performed, or where data are unavailable. Use of these maps is recommended as a source of information in performing federal jurisdictional determinations of waters of the United States (Environmental Laboratory 1987).

Regardless of the exact percentage that is ultimately determined to be regulated "waters" at the Pebble deposit and surrounding drainages, all of the area is fish and/or wildlife habitat. Inasmuch as it would not be possible to mine with Pebble deposit without a regulated discharge of dredged or fill material, the impacts to areas proposed for the pit, the tailings storage facilities, the waste rock dumps, the power plant, the mill site, crushers, etc. would all be considered enabled by the 404 discharges. Accordingly, a Department of the Army permit pursuant to Section 404 of the CWA would be authorizing the destruction of thousands of acres of fish and wildlife habitats.

The proposed project footprint for the smallest initial phase (25-year project) covers over 14 square miles -- over 9200 acres of fish and wildlife habitat. It seems clear that the losses of wetlands and aquatic areas would be greater in the areas overlying and adjacent to the Pebble deposit than in the Area G drainage proposed for the TSF (National Wetlands Inventory maps -- Figure 9). The area of the Pebble deposit is a low-gradient drainage divide characterized by wetlands, ponds, and interconnecting streams; the U.S. Fish and Wildlife Service has categorized the majority of the 5200-acres proposed for the mine pit and waste rock disposal areas as varying types of wetlands, open water bodies, and riverine areas (National Wetlands Inventory map, Figure 10).

These acreage figures are conservative, inasmuch as they are based upon the first 25-year phase of mining the Pebble deposit, and the impacts associated with additional phases that could extend beyond 78 years would be significantly greater,[60] insofar as habitat losses are concerned. Based on the NWI maps of the areas at and surrounding the Pebble deposit, the extent of wetlands that exist overlying and south of the Pebble deposit are likely to represent the highest relative abundance of wetlands than at any other areas of future expansion. The TSF's will likely be proposed in surrounding drainages that contain thousands of acres of wetland and aquatic resources, including riffle-and-pool special aquatic sites, anadromous fish habitat, wildlife habitat, and other types of regulated waters.

[60] The size of the mine pit alone, independent of the surrounding waste rock disposal areas would grow by more than 50% between the 25-year and 45-year proposed plans (from Wardrop 2011, Figure 1.7.2.), but the acreage losses associated with additional TSF's is many times greater.

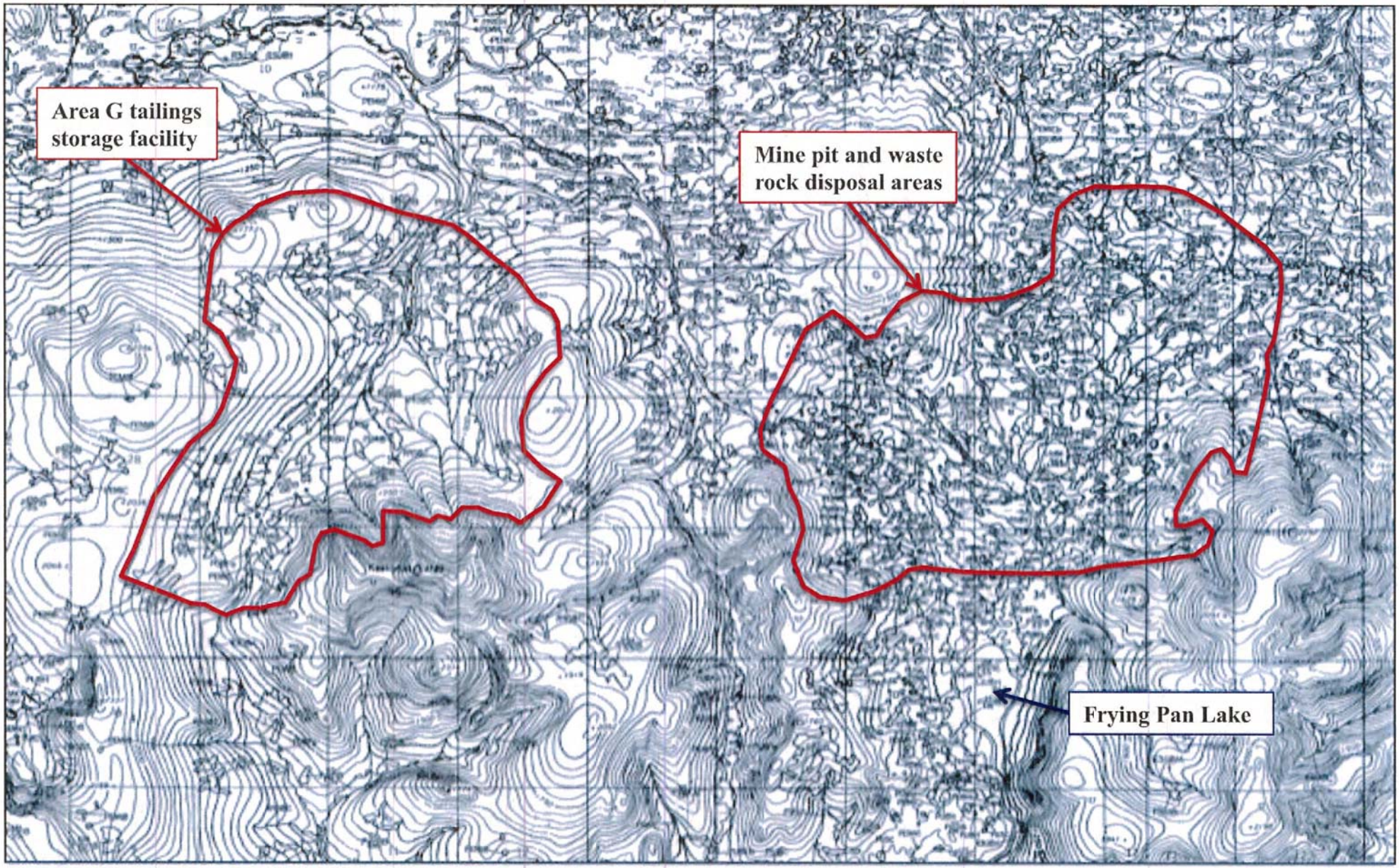


Figure 9: National Wetlands Inventory designations of wetlands and deepwater habitats in the vicinity of the Pebble deposit. Data plotted on Iliamna (D-6 and D-7) quadrangles based on July 1978 color infra-red photography (1:65,000 scale). Underlying topography from U.S. Geological Survey 1994. Maps prepared by the United States Department of the Interior, Fish and Wildlife Service. Approximate areas of mine features for the first 25-year phase of the Pebble Project are outlined in red (from Wardrop 2011). Frying Pan Lake shown to help orient the reader.

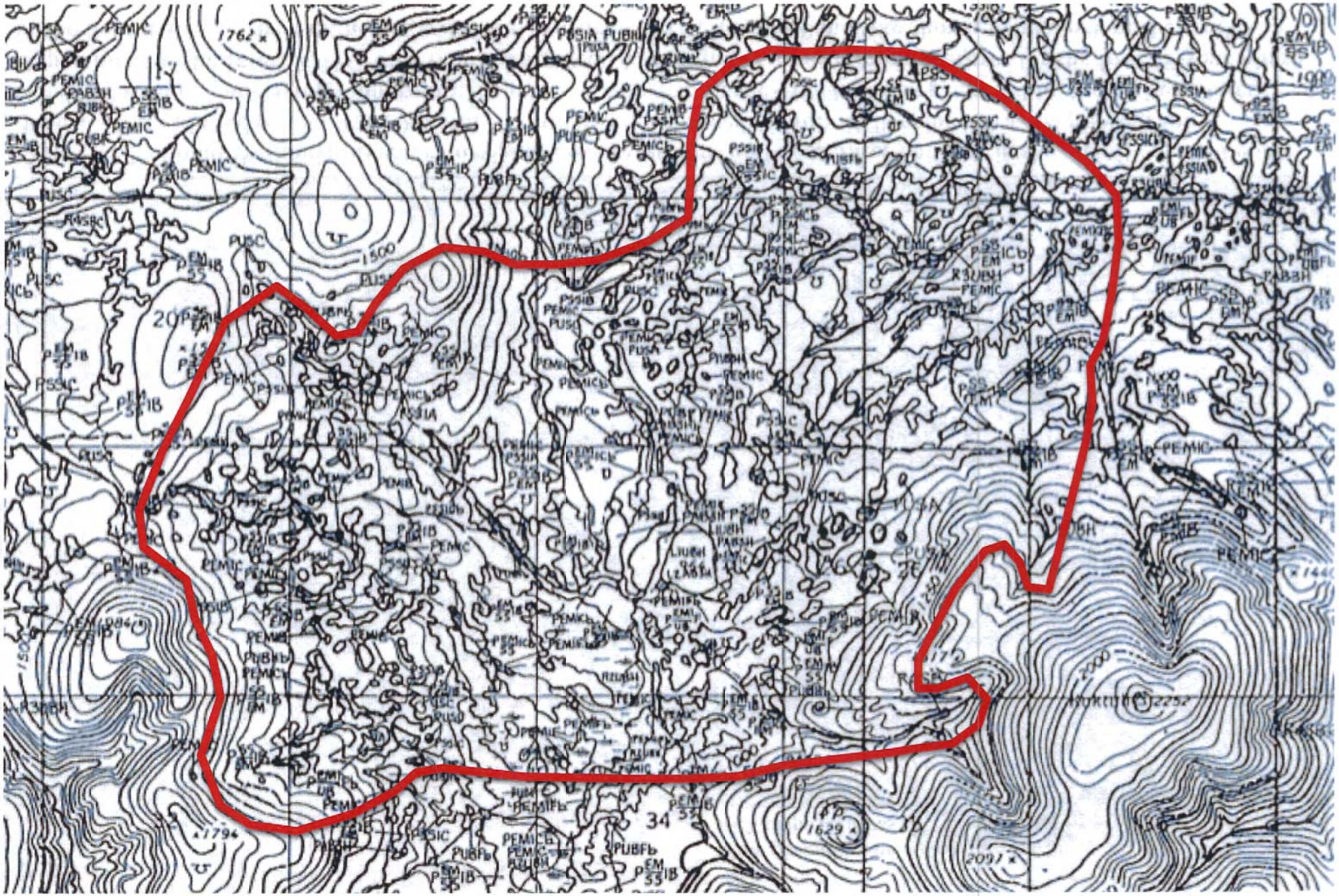


Figure 10: Areas mapped by the U.S. Fish and Wildlife Service as wetlands and deep-water habitats (Cowardin et.al. 1979) that would be excavated or filled for a mine pit and waste rock disposal areas during the initial 25-year phase of the Pebble Project. Approximate outer boundary of these areas is outlined in red (from Wardrop 2011).

2. Significant degradation due to toxicity of mine wastes

Discharges of mining waste products to waters of the United States from mining the Pebble ore body pose threats on-site as well as to downstream areas through the potential production of acid mine drainage (AMD) and leaching of metals such as copper. Geochemical testing of the ore body, overburden, waste rock, and mine tailings has been conducted by NDM and may still be underway (Northern Dynasty Mines Inc. 2005a; SRK Consulting, Inc. 2006; SRK Consulting, Inc. 2008).

a. Acid-Generation Potential

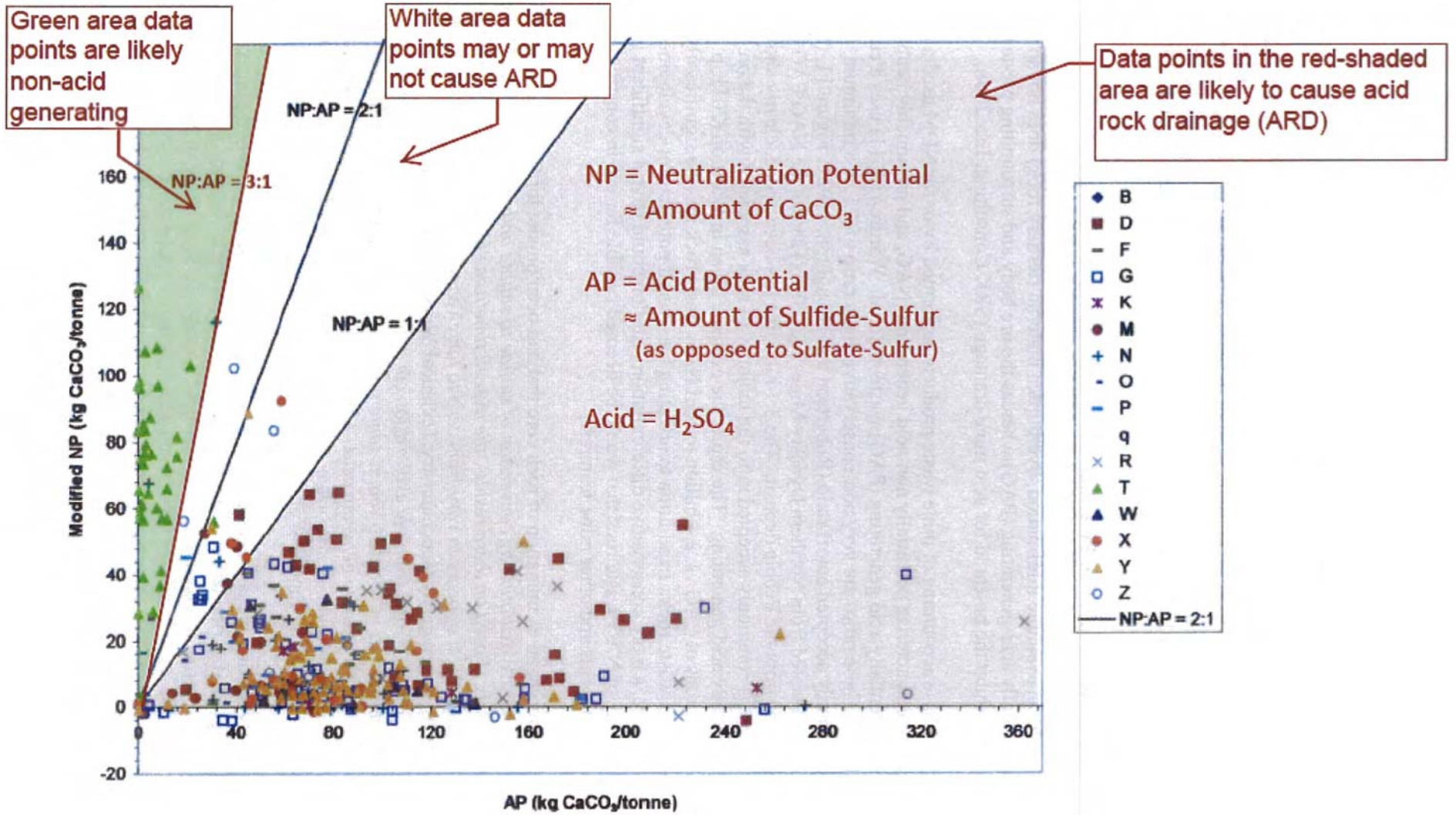
Based on available information, overburden material (tertiary rock) does not appear to be potentially acid-generating (PAG) whereas the ore body and surrounding pre-tertiary waste rock does exhibit the potential for acid mine drainage (SRK Consulting, Inc. 2008).

Acid-base accounting of mine waste products performed by or for NDM used a cutoff ratio of 2:1 to characterize potentially non-acid generating (NAG, and presumably neutralizing material) vs. potentially acid generating (PAG) waste material. Wardrop (2011) uses a cut-off ratio of 1.6:1. These ratios are very non-conservative and a ratio of 3:1, at a minimum, is a more commonly accepted cutoff ratio (Robertson and Broughton, 1992). Figure 11, (from Chambers 2006, adapted from Northern Dynasty Mines Inc. 2005a) shows the NAG:PAG data for 399 rock samples from the Pebble deposit. The 3:1 ratio line has been added, clearly showing that when using this commonly accepted ratio the majority of rock associated with the ore body is potentially acid generating. Therefore, the estimate given in Wardrop (2011, p. 360) of 0.6 million tons of PAG vs. 2.4 billion tons of NAG waste rock may be significantly skewed in favor of NAG waste rock. In addition to affecting the overall potential for development of acid mine drainage, a more conservative differentiation criterion could have a significant impact on the quantity of NAG waste rock that would be deemed suitable for use in constructing the tailings embankments and other mine features.

In addition, an examination of rock core that had been on-site for 0-15 years showed "*progressive oxidation by conversion of sulfide to sulfate and decreasing neutralization potentials. Based on these results, the overall timeframe for acidification of waste rock from the Pebble Project appears to vary from zero to forty years*" (Northern Dynasty Mines Inc. 2005a). Also, the interagency Geochemistry Technical Working Group found that "*There is some data on the onset of ARD from old exploration cores that were left at the site. The average rocks start generating acid in about 20 years; some samples were instantaneous, others are estimated to take up to 60 years to generate acid. Kinetic tests done in the laboratory show a close correlation for these results when corrected for temperature (the laboratory is warmer)*" (Geochemistry Technical Working Group, Pebble Project, Final Minutes for January 3, 2008).

Two types of mine tailings would be produced that are described as non-pyritic bulk scavenger tailings, and pyritic tailings comprised of cleaner scavenger flotation tailings combined with tailings from a leach circuit to recover gold. Acid-base accounting of bulk scavenger tailings and cleaner scavenger tailings from bench-scale testing of "potential ore-type material" was conducted in 2004 (Northern Dynasty Mines Inc. 2005a). It is not clear how representative the

Figure 11: Neutralization potential versus acid potential in 399 rock samples from the Pebble deposit. Figure taken from, and used with the permission of, Chambers (2006).



ore-type material may be relative to the entire ore body. The cleaner tailings and bulk tailings were combined and showed an NP:AP ratio of 3.7:1 (Northern Dynasty Mines Inc. 2005a), although the two cleaner tailings samples had ratios of 2.4 and 2.9. No ratio or data were provided for the pyritic tailings from the gold leach circuit but they are presumed to be acid generating based on their pyrite content (Wardrop 2011). Reagents used in the froth-flotation circuits would include xanthates, fuel oil (Wardrop 2011) and potentially cyanide in the gold leach process (no description of the leach process is provided in Wardrop, but cyanide is commonly used in gold leaching operations).

b. Metals Leaching

Humidity cell tests and field weathering tests were undertaken to examine the potential for acid generation and metals leaching from various types of waste rock (SRK Consulting, Inc. 2008). These tests attempt to mimic wet-dry cycles that occur in a natural setting, such as a waste rock. They are also valuable in ascertaining whether presumed neutralizing minerals present in the waste rock (*e.g.*, calcite, siderite) are actually available to react with the acidifying minerals (*e.g.*, pyrite) in a time frame that would prevent acid generation.

Results available indicate the following:

- Field weathering tests designed to evaluate leaching behavior of waste rock under field conditions showed that pre-tertiary rock samples produced leachates that ranged from 1,100 ppb to 20,100 ppb copper (SRK Consulting, Inc. 2008). The projected water quality criterion for copper for mining the Pebble deposit is in the range of 2.85 ppb (Ecology and Environment, 2010).

- Humidity cell tests for leachate production from cleaner tailings samples showed "long-term increasing trends for copper" (SRK Consulting, Inc. 2006). As shown in Figure 12, copper leachate loading rates from the cleaner tails increase over time.

c. Conclusions regarding significant degradation due to toxicity of mine wastes

Based on available data, it is clear that a substantial risk exists for acid mine drainage (AMD) to develop in waste rock piles, especially considering the non-conservative approach to characterizing NAG vs. PAG (2:1 vs. 3:1 or higher ratio). As runoff and seepage from the waste rock piles, along with pit water, would be directed to the TSF during mine operation, acidic conditions could develop within the TSF even if potentially acid-generating pyritic tailings do not generate acid mine drainage. As pH is lowered, metals contained within the tailings, including copper, would become more mobile (U.S. Environmental Protection Agency 2003, Appendix C). There is also potential for leaching of copper from the cleaner tailings and gold leach tailings, which would be stored sub-aqueously within the TSF, even without AMD.

As stated in Section V.B.1, Water Quality, no definitive conclusions can be made regarding the water quality that would develop over time within the TSF. But given the risks of AMD, leaching of copper and other metals within the TSF and the high permeability of the native materials that comprise and would underlie the site G TSF, the potential for metals, particularly

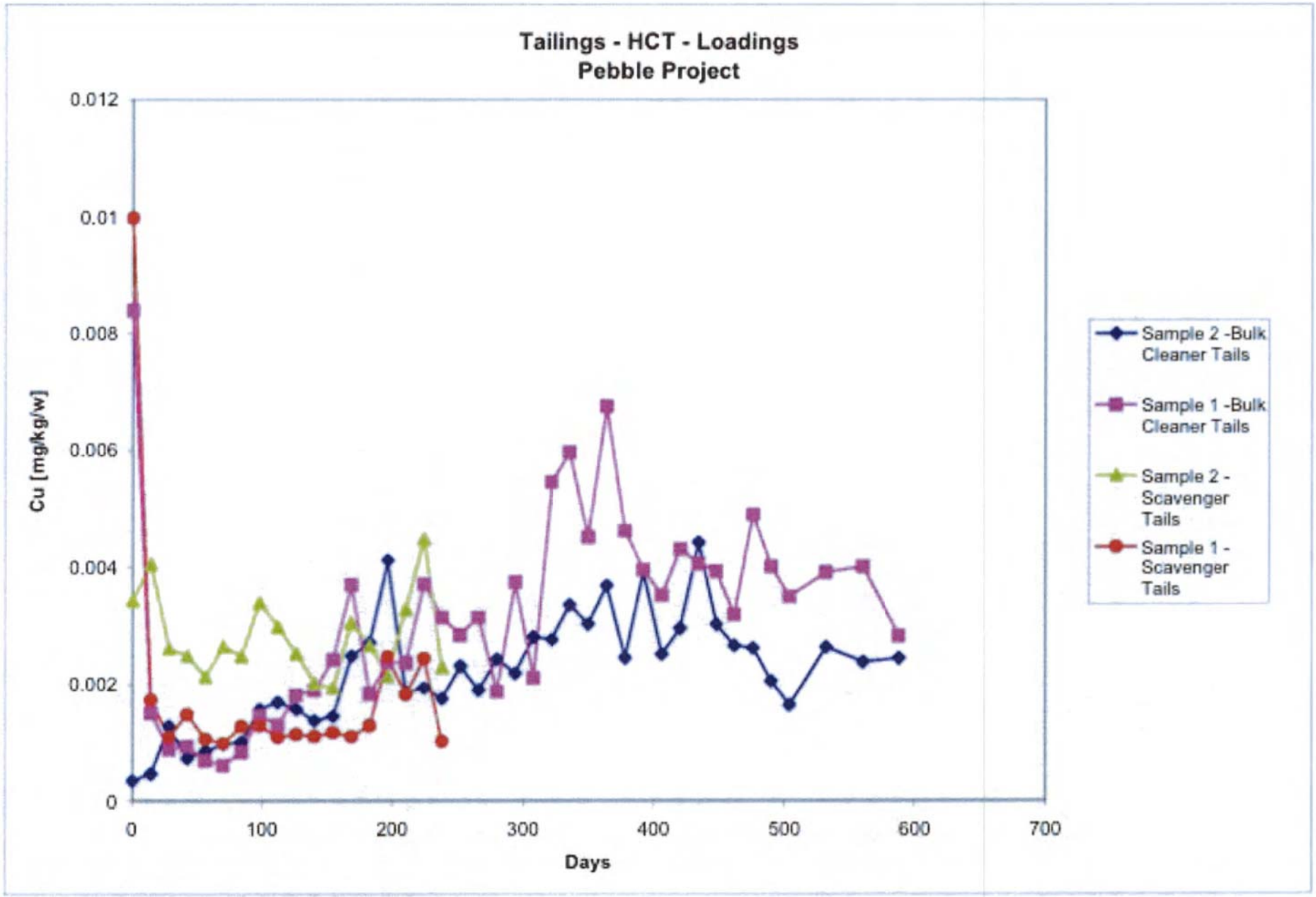


Figure 12: Humidity Cell Test Results for Tailings Showing Increasing Leaching Rate for Copper Over Time in Cleaner Tailings (reproduced from SRK Consulting Inc. 2006, page 183)

copper, to reach nearby streams would likely present unacceptable risks to native fish populations. Regardless, it seems quite apparent that the tailings and waste rock proposed to be discharged as fill material are not likely to be deemed "clean" fill material suitable for unconfined disposal in waters of the United States.

3. Significant degradation due to hydrologic impacts

NDM applied to the State of Alaska in 2006 for the rights to withdraw up to 32 billion gallons of water each year from the North and South Forks of the Koktuli River and Upper Talarik Creek drainages. This is more than or at least comparable to the water usage for the entire city of Anchorage (U.S. Geological Survey 2006). In addition to water withdrawn from surface and groundwater sources, net precipitation will inevitably contribute very significant quantities to the overall water budget for the project (see section IV.B.).

The Nature Conservancy commissioned an Ecological Risk Assessment (ERA), based on EPA's *Guidelines for Ecological Risk Assessment* (U.S. Environmental Protection Agency 1998), of the potential impacts from a Pebble Mine project (based on 2006 water rights applications by Northern Dynasty Mines, Inc.). This ERA focused heavily on hydrologic modifications and their potential effects on local anadromous streams (Ecology and Environment 2010). The ERA concluded that approximately 68 miles of stream habitat would be lost and "*up to 78 stream miles would exhibit some form of flow reduction in the three watersheds evaluated.*"

Averaged annual post-operation flow reductions per the ERA for the three watersheds that would be directly affected by the project are predicted to be:

- The North Fork Koktuli (NFK) downstream of the site G tailings impoundment, where it joins three other sub-basins, would have a 21% flow reduction;

- The South Fork Koktuli (SFK) would have a 68% flow reduction downstream of the site A tailings impoundment. (However, it appears that the project sponsor is no longer proposing site A as a tailings storage facility, and this estimate probably over-estimates the potential flow reduction in the SFK); and

- Upper Talarik Creek (UTC) is predicted to have an 80% reduction 2.5 miles downstream of the mine pit, a 20% reduction 8 miles downstream of the mine pit, and a 12% flow reduction 18 miles downstream of the mine pit.

This loss of instream flow is predicted to exacerbate summer low-flow conditions, resulting in reduced pool and backwater rearing areas for juvenile salmonids. This would result in greater competition for food and cover and remaining pools in affected stream reaches could experience higher temperatures. As stated in the ERA (Ecology and Environment 2010; p.107-8),

"Reduced low flow during the incubation or inter-gravel phase would also act to reduce salmon production within affected streams. Low flows would limit adult salmon entry into streams or affect their movement up river to stage for spawning. It is predicted that after mine development, velocities during the critical spawning/embryo development period (January-March) within all

three streams would be less than optimum. Low flow conditions, along with other associated reductions in water quality conditions (i.e., lowered dissolved oxygen, higher water temperatures) would likely increase stress on individuals, potentially resulting in mortality. Flow reduction would also affect substrate composition in riffle areas within affected mainstem segments through embedded conditions and reduced sediment oxygen concentrations. This in turn would act to diminish the quality of redds, ultimately resulting in negative impacts during embryonic development and fry emergence."

The 2006 Water Rights Applications submitted by Northern Dynasty Mines proposed a "zero-discharge" scenario during operations.[61] However, as discussed in Section V.B, net precipitation during all phases of the project (construction, operation, post-closure), would inevitably result in discharges of runoff from disturbed areas (*e.g.*, tailings impoundments, waste rock piles). The ERA, however, is based on the assumption that the project would in fact be a zero-discharge project. As such, the flow reductions predicted in the ERA may be overstated. But to the extent actual flows may be higher than predicted in the ERA, the difference would be comprised of mine site wastewater discharges.

The risks of significant degradation of the aquatic resources affected by the project could only be prevented by isolating, capturing and treating all mine wastewater discharges, and by discharging properly treated effluent that not only meets WQC but is released at rates that mimic natural stream flow regimes. The ability, or lack thereof, to achieve this objective, is addressed under Mitigation, section V.D., below.

D. Compliance with the Guidelines: Mitigation

1. Mitigating impacts to fish and wildlife habitat

Under the Guidelines and 2008 Mitigation rule, mitigation measures are not relevant unless or until a proposed discharge of dredged or fill material has been determined to be the LEDPA. If a less-damaging alternative is practicable to achieve the basic project purpose, then no permit can be issued for a more-damaging alternative, regardless of the compensatory mitigation that is proposed by a project sponsor.

As discussed above, mining the Pebble deposit may be avoidable due to the availability of alternative ore deposits, the mining of which may result in less environmental harm. If so, then compensatory mitigation measures could not make discharges associated with mining the Pebble deposit permittable. However, for the purposes of this section of the report, an assumption is made that discharges associated with mining the Pebble deposit are unavoidable to achieve the basic project purpose of extracting copper and associated minerals.

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[61] Although proposed as "zero-discharge," the groundwater right applications noted that there could be impacts to stream flows. To mitigate such impacts the applications state that "*As necessary to meet state and other regulatory requirements to protect these other resources, this flow reduction will be mitigated. A mitigation example would be supplying water to the North Fork Koktuli from other sources (wells, pipeline, treated discharge from the tailings storage facility at Site G)*" (Northern Dynasty Mines Inc. 2006d-f)). As such, it appears that some discharge of treated wastewater was contemplated.

Impacts from the mining the Pebble deposit are described above and, at a minimum, would result in the direct loss of over 9200 acres of fish and wildlife habitat, including wetlands, open-water habitat, and many miles of streams that support anadromous fishes.

The project sponsors have indicated that they have made efforts to characterize the habitats within 25 miles[62] of the Pebble deposit in order to site necessary mining facilities, particularly tailings storage facilities, in drainages that are less valuable to fish and wildlife resources (Wardrop 2011). Of the 15 proposed tailings storage facility sites, 3 sites were selected for further study, including sites that support anadromous fishes. However, Wardrop (2011) only shows one site (North Fork Koktuli River drainage -- Area G) and suggests that the TSF proposed therein would have a capacity for the tailings that would be produced in the first 25 years of mining operations; an earlier proposal associated with the 2006 water rights applications (Knight Piesold Ltd. 2006b) showed capacity for only about one fourth of these tailings at Area G. The specific locations and dimensions of the additional TSF's are not presented, but based upon its water rights applications in 2006, it seems likely that these additional facilities would be in adjacent drainages, including the South Fork Koktuli River, that either support anadromous fishes directly, or that are tributary to such waters. Furthermore, no measures are described in Wardrop (2011) to attempt to offset the habitat losses associated with the pit, the waste rock disposal areas, or the tailings impoundment(s).

In fact, it is not likely that compensatory mitigation is feasible near the Pebble deposit, nor within the Upper Talarik Creek or Koktuli River drainages. There appear to be no degraded habitat areas of similar function that could be restored or enhanced. Even if there were, given the large acreages involved, appropriate compensatory mitigation measures should be at ratios that restore or enhance a greater area per acre than what would be permanently destroyed by mining the Pebble deposit.

Furthermore, any proposals to offset the losses of anadromous fish habitat with hatcheries should be rejected. According to the Northwest Fisheries Science Center (NOAA Fisheries), wild salmon populations have declined dramatically over the past several decades, "*despite, and perhaps sometimes because of, the contribution of hatcheries. Many salmon stocks in Washington and Oregon are now listed as either threatened or endangered under the U.S. Endangered Species Act. With this decline has come an increased focus on the preservation of indigenous wild salmon stocks.*"[63] Remaining natural populations provide a better chance for long-term survival of salmon inasmuch as these populations have evolved in response to significant environmental changes over many thousands of years, and can be expected to do so in the future.

Although there do not appear to be opportunities for compensatory mitigation at or near the Pebble deposit, EPA's 2008 Mitigation Rule and its 1994 mitigation sequencing for Alaska do not provide for mitigation measures that would occur outside of the watershed within which the impacts for a proposed discharge would be permitted. Nor does the Mitigation Rule provide for mitigation measures for impacts in one State to be offset in another State or nation. Accordingly,

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[62] The project sponsors included an evaluation of disposing of tailings by transporting and discharging them into Iliamna Lake.

[63] http://www.nwfsc.noaa.gov/resources/search_faq.cfm?faqmaincatid=3 - faqid61

any proposals that might be brought forth by the project sponsors to do so should be rejected as not complying with the mitigation requirements of the Guidelines or the Mitigation Rule.

It may not be, in fact, reasonable or practicable to offset the impacts of mining the Pebble deposit through the use of compensatory mitigation. If so, then the post-project condition for plant and animal populations will certainly not be at a "*higher state*" than the pre-project conditions, as envisioned by the Guidelines [see 40 CFR 230.75(d)], and the determination that the project would cause or contribute to significant degradation of the waters of the United States would be based solely on the otherwise unmitigated project impacts. Under these circumstances, a finding of non-compliance with the Guidelines would be appropriate.

2. Mitigating potential impacts due to toxicity

As discussed in Sections V.B.1 and V.C.2, mining the Pebble deposit would generate an unprecedented quantity of contaminated water requiring treatment relative to other major Alaska hardrock mines (see Table 1). In addition to the scale of proposals to mine the Pebble deposit, the hydrologic setting is unique. The project area is dominated by wetlands and shallow groundwater, creating multiple pathways for the migration of contaminants to affect aquatic organisms, including salmon in various life stages. The key to mitigating any potential toxicity to nearby aquatic organisms is to effectively isolate the contaminants from the surrounding shallow aquifers and streams. Once isolated, the contaminated water may then be collected and routed for treatment to meet regulatory requirements.

Based upon earlier water rights applications, NDM apparently intends to rely on the bulk tailings to form an impervious seal on the bottom of the tailings impoundments (Northern Dynasty Mines, Inc. 2006b). Seepage cut-off walls would be part of each tailings embankment and seepage/leachate collection ponds would be constructed at the base of all tailings embankment structures. Waste rock piles would not be lined but would be located within the cone of depression of the mine pit (Wardrop 2011). Waste piles would have seepage cutoff walls at their lower ends and runoff capture ponds. Ultimately, mine pit water and waste rock dump runoff (and seepage/leachate) would be directed to the TSF for storage and eventual treatment.

As stated in Section V.B.1 above, the site G TSF would be underlain by sand and gravel deposits and highly weathered (*i.e.*, fractured) bedrock. According to Wardrop (2011, p. 350) bedrock is "*typically found to be fractured to depths of approximately 30 feet below the overburden contact, with some locations showing fractured bedrock depths of approximately 130 feet below the overburden contact. Localized faults are also present.*" The bulk mine tailings would be "*uniformly graded, consisting of sand and silt-sized particles, with a P_{80} of 200µm.*" Whereas the permeability of the tailings may be considered low based on this particle size (Wardrop does not provide any permeability data), they would nevertheless be permeable and over time pore water in the interstices of the tailings would migrate into the groundwater system that, as indicated above, is highly porous. Contaminants would therefore not be isolated and over time would likely migrate to surface waters.

To mitigate these potential impacts (and to overcome an "unsuitable as fill material" determination by EPA and the Corps of Engineers regarding tailings and waste rock), placement of an engineered liner authorized under Section 404 could be considered. Such a liner would be

constructed of clean fill material that includes a synthetic or geo-synthetic liner of extremely low-permeability material, combined with an extensive internal drainage system. The drainage system would capture seepage/leachate and provide a preferential pathway to direct it to collection ponds for subsequent treatment and thus largely prevent seepage/leachate from entering groundwater and flowing into nearby streams. Such a system has been installed at the Pogo Gold Mine near Delta Junction, albeit on a much smaller scale.

The costs associated with lining each TSF would certainly be substantial. However, such added costs should not be a consideration with respect to determining whether this mitigation measure would be "appropriate and practicable" in the context of 40 CFR 230.10 (d). If this mitigation measure, or any other, would avoid an otherwise "unsuitable as fill material" determination and prevent significant degradation of water quality in nearby streams, it must be considered both appropriate and practicable, regardless of the grade of ore that is being mined. The fact that other Alaska hardrock mines, including Pogo and Greens Creek, permanently store their mine tailings on engineered liners reinforces this point.

3. Mitigating impacts due to hydrological modifications

Impacts to local fish populations from flow reductions caused by water withdrawals for mine development and operation purposes (*e.g.*, pit de-watering) could potentially be mitigated by timing releases and flows from the wastewater treatment plant(s) to mimic the natural flow regimes in local headwater streams. Achieving this objective would depend on effectively isolating, capturing, and treating wastewater produced by the project to meet WQC at all times. As discussed in previous sections (see also Table 1), the unprecedented scale of the potential wastewater discharges compared to other major hardrock mines in Alaska (or elsewhere), along with the lack of any available dilution prior to discharge present enormous challenges.

Assuming treated wastewater discharges would be directed to the North and South Fork Koktuli Rivers and Upper Talarik Creeks, these headwater streams would be effluent-dominated streams for much if not most of the year. The risks of failing to mimic the water quality and flow characteristics that make these and all the other streams within the Bristol Bay watershed such ideal spawning and rearing habitat for salmon, including temperature, TDS and hardness, would be quite high given all the parameters that would need to be optimized season by season for many decades. The entire system would be dependent on many pumps, pipelines and maintenance-intensive water treatment plants requiring periodic sludge and brine removal, filter back-washing and replacement of equipment, not to mention a reliable, long-term power supply.

E. Significant impacts to Aquatic Resources of National Importance (ARNI)

In its review of applications for authorization to discharge dredged or fill material into waters of the United States, including wetlands, EPA has identified many areas that it considers to be aquatic resources of national importance (ARNI), pursuant to its 1992 Memorandum of Agreement (MOA) with the Department of the Army.[64] These include rivers, streams, lakes, wetlands, and even seasonally temporary water bodies (vernal pools).

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[64] Clean Water Act Section 404(q) Memorandum of Agreement Between the Environmental Protection Agency and the Department of the Army. Signed August 11, 1991 by Martha G. Prothro, Acting Assistant Administrator for

In Alaska, EPA has identified ARNI resources in 17 instances since 1992 (less than one per year), where the agency believed that the proposed discharge(s) of dredged or fill material associated with a permit application might (or would) result in unacceptable adverse impacts to aquatic resources of national importance (Table 2). The ARNI resources identified by EPA in the Alaska cases included wetlands, tidal waters, and tributary rivers and streams.

The small number of such findings does not mean that none of the hundreds of other permit applications involved valuable wetland or aquatic resources. Rather, it means that the potential project impacts in 17 of those applications were significant enough that EPA was required to formally make an ARNI determination to preserve its ability to utilize the 404(q) MOA to resolve differences with the Corps, had the Corps sought to issue a permit over EPA's objections.

There seems little question that the wetland and aquatic resources that exist at the Pebble deposit and surrounding drainages exceed the threshold of aquatic resources of national importance, if not international importance. The magnitude of the losses that would result from mining the Pebble deposit, the additional losses and degradation associated with short- and long-term hydrological modifications, and the long-term risks associated with the tailings impoundments and long-term wastewater treatment further support an ARNI determination.

F. Comparing impacts of mining the Pebble deposit with impacts that EPA has found to be unacceptable under its 404(c) authority

EPA's actions under its 404(c) authority are not specifically limited to discharges associated with ARNI resources, particularly since that term first appears in EPA's 1992 MOA with the Army, and all but two of its thirteen 404(c) actions were taken before that MOA was signed. Accordingly, there is no way to determine, after the fact, whether EPA would have determined that the resources at stake in its 404(c) actions that pre-date the 1992 MOA would qualify as aquatic resources of national importance. However, given how infrequently EPA has exercised its 404(c) authority since being granted that authority in the late 1970's, it is worthwhile to review the cases where EPA has elected to take action.

EPA has completed a total of 13 actions under its Section 404(c) authority, beginning 30 years ago (Table 3). Eleven of these occurred between 1981 and 1990, ten of which (77%) were initiated and completed during the Reagan and G.H.W. Bush Administrations. Only two 404(c) actions have been completed in the last 20 years. To date, only one 404(c) action has been completed in a State west of the Mississippi (the Two Forks Dam proposal in Colorado in 1990). However, other proposed discharges have led to EPA initiating 404(c) actions, including actions

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Water, U.S. EPA, and Nancy P. Dorn, Assistant Secretary of the Army for Civil Works, Department of the Army. 10 pages. Prior to entering into the 1992 MOA, EPA and the Corps followed procedures under a 1985 interagency agreement that similarly established dispute-resolution policies and procedures, but had no limitations based on ARNI resources. Prior to 1985, there were no dispute-resolution policies or procedures to which these agencies had agreed, and EPA only had its 404(c) authority as a last-resort to prevent permits being issued for projects that EPA considered unacceptable in their present form.

Table 2. Alaska cases where EPA Region 10 identified Aquatic Resources of National Importance (ARNI) under EPA's Memorandum of Agreement with the Army pursuant to Section 404(q) of the Clean Water Act

DATE	APPLICANT	ARNI
1993	Petro Star, Inc.	Duck Flats, Valdez
1994	Mr. Cusack	Klatt Bog, Anchorage
1998	City and Borough of Juneau	Mendenhall Wetlands/Jordan Creek, Juneau
1998	Alaska Department of Transportation & Public Facilities	Auke Bay/Auke Nu Cove, Juneau
1999	Anchorage International Airport	Turnagain Bog, Anchorage
2001	Mr. Bardarson	Resurrection River, Seward
2001	Alaska Department of Transportation & Public Facilities	Hay Flats/Spring Creek Wetlands, Palmer
2001	Alaska Department of Transportation & Public Facilities	Wasilla Creek Wetlands, Wasilla
2002	City of Homer	Kachemak Bay, Homer
2002	Anchorage Water and Wastewater Utility	Campbell Creek Wetlands, Anchorage
2005	Alaska Department of Transportation & Public Facilities	Kenai Peninsula – Anchor River, Deep Creek, Kenai River, Ninilchik River, Resurrection River
2005/2009	ConocoPhillips Alaska, Inc	Colville River Delta, North Slope
2006	Alaska Department of Transportation & Public Facilities	Berners Bay, Juneau
2007	Walmart Stores, Inc.	Kenai River Tributaries, Soldotna
2007	Mr. Carlos and Mr. Cullip	Cook Inlet and Stariski Creek, Anchor Point
2010	City and Borough of Juneau	Gastineau Channel, Douglas
2010	Alaska Railroad Corporation	Tanana River

Table 3: A summary of 404(c) final determinations made by EPA since 1981. Estimated resources losses associated with mining the Pebble deposit are included for comparative purposes only.

Year	Project Type	State	Acres/Miles	Impacts*	Alternatives?
1981	Landfill	FL	103 ac	F,S,W,R	Yes-uplands
1984	Fiber recycling plant	AL	25 ac	F,W	Yes-uplands
1985	Hunting/Aquaculture	SC	900 ac	F,R	Yes-uplands
1985	Flood control/Reclamation**	LA	3000 ac	F,S,W,R	Not determined
1986	Shopping mall	MA	53 ac	W	Yes-other site
1988	Warehouse complex	NJ	58 ac	W	Yes-violation
1988	Reclamation/farming	FL	432 ac	F,W,R	Not determined
1989	Reservoir/mitigation	GA	957 ac	W	Not determined
1989	Reservoir	VA	425 ac waters 792 ac forest	W	Yes-avoidable
1990	Reservoir	RI	575 ac	W,R	Yes-avoidable
1990	Reservoir	CO	30.1 mi	F,R	Yes-avoidable
2008	Pump station/flood control**	MS	28,400 - 67,000 ac	F,W,R	Yes
2011	Coal mine	WV	6.6 mi	F,W	Yes
201?	Pebble Project	AK	9200+ acres fish and wildlife habitat, 20+ miles streams	F,W,R	Yes – alternative ore deposits

** F = fish; S = shellfish; W = wildlife; M = municipal water supplies; and R = recreation*
*** Projects proposed by the U.S. Army Corps of Engineers for the lower Mississippi River*

in the west, but these additional cases have been resolved, leading to no permanent restrictions or prohibitions on the proposed discharges.[65]

EPA's actions under its 404(c) authority have placed restrictions or prohibitions on a variety of proposed activities, including public and private development. The two largest projects that have been prohibited to date were government proposals from the U.S. Army Corps of Engineers for facilities intended to provide flood control and/or reclamation in the lower Mississippi River; the potential impacts of these two projects on aquatic resources and wildlife were estimated as many thousands of acres. Other projects that have been restricted or prohibited include developments of less than 100 acres (smallest at 25 acres), stream impacts ranging from 6.6 miles to over 30 miles, and reservoir impacts of several hundred acres. Four of the 13 projects restricted or prohibited by EPA have been for reservoirs.

The bases for the determinations that the impacts of the discharge would be "unacceptable" are varied. For example, the first 404(c) action taken by the agency in 1981 was over the nature of the material that was being used to fill a wetland site in Florida.[66] EPA took action to stop a permittee from filling wetlands with garbage after a permit had been issued to fill those same wetlands with clean fill material; EPA had not objected to the original permit application.

In another case, EPA determined that the impacts of discharges associated with a proposed shopping mall were unacceptable, because EPA determined that these impacts were avoidable;[67] the 54-acre red maple swamp that would have been filled was considered somewhat degraded and was surrounded on three sides by freeways, but EPA considered its loss to be unacceptable (in spite of proposed compensatory mitigation), because EPA determined that a less-damaging alternative site was practicable. Only in the proposed Two Forks Dam in Colorado was a "world-class" resource identified, that being a reach of the South Fork of the Platte River that supported a particularly renowned sport fishery for trout.[68]

At a minimum, under the 25-year scenario, mining the Pebble deposit would result in the destruction of over 9200 acres of fish and wildlife habitat, including thousands of acres of wetland and aquatic sites that overlie and are adjacent to the Pebble deposit. The impacts

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[65] For example, in 1987, EPA Region IX (San Francisco) initiated action pursuant to Section 404(c) to stop the Corps of Engineers, Los Angeles District, from issuing a permit for the proposed Pamo Dam and Reservoir in San Diego County. This dam would have inundated approximately 1800 acres, of which approximately 100 acres were jurisdictional streams and adjacent riparian wetlands. EPA had determined that a less-damaging alternative existed, and, after it initiated 404(c) proceedings in the Federal Register, the project sponsor withdrew its permit application and pursued alternative means of providing emergency water supplies. EPA Region X (Seattle) initiated 404(c) action pursuant to a proposed drill pad and access road on the north slope of Alaska. This case was also quickly resolved after EPA issued a public notice with its draft determination. The case involved several acres of wildlife (bird) habitat.

[66] Final Determination of the Administrator concerning North Miami Landfill Site pursuant to Section 404(c) of the Clean Water Act. January 19, 1981

[67] Final Determination of the Assistant Administrator for External Affairs concerning the Sweedens Swamp site in Attleboro, Massachusetts, pursuant to Section 404(c) of the Clean Water Act. May 13, 1986. This case was subsequently litigated in Bersani v. Robichaud, 850 F2d 36 (2d Cir 1988)

[68] Final Determination of the U.S. Environmental Protection Agency's Assistant Administrator for Water pursuant to Section 404(c) of the Clean Water Act concerning the Two Forks Water Supply Impoundments, Jefferson and Douglas Counties, Colorado. November 23, 1990

associated with fully exploiting the Pebble deposit are proportionally greater.[69] It is important to note that these are only the direct on-site impacts, and do not consider the additional direct impacts to downstream areas, nor do they consider the potential secondary and long-term impacts described earlier.

It seems likely that the quality of the resources at risk associated with a) mining the Pebble deposit, b) the use of nearby drainages as enormous tailings storage impoundments, and c) direct and secondary impacts to waters downstream from these facilities are without equal when compared to any other resources at stake in EPA's previous 404(c) actions.

G. Consideration of Public Interest Factors

Whereas it is not EPA's responsibility to consider the Corps' public interest determination in its separate 404(c) authorities, the interests of the public may be relevant to its consideration of whether impacts of a project are environmentally unacceptable.

Copper and associated mineral deposits exist worldwide. In fact, the foreign corporations that are proposing to extract and export metals from the Pebble deposit have other holdings that they consider to be practicable alternatives, inasmuch as they are pursuing them simultaneously, either directly or through subsidiaries. There may be other ore deposits that the project sponsors could obtain, utilize, or manage to extract copper that would result in far less environmental harm and long-term risk than mining the Pebble deposit.

Runs of sockeye salmon do not exist worldwide, and in fact occupy only a fraction of their historical range. By far, the largest remaining runs utilize the Bristol Bay watershed, including the three drainages that emanate from the area of the Pebble deposit. Losses of this habitat cannot be replaced within the Bristol Bay watershed. If and when the Pebble deposit is exploited for its minerals, other deposits will continue to be exploited elsewhere. If the runs of salmon in Bristol Bay are lost or degraded, their loss cannot be replaced.

Copper is not so rare as to be endangered. Anadromous fishes and their habitats are. Hardrock mines have a record of causing long-term harm to water quality and fishery resources. EPA estimates that mining in the western United States has contaminated stream reaches in the headwaters of more than 40 percent of the watersheds in the West, and that remediation of abandoned mines may cost up to $35 billion or more.[70] EPA has been cautioned by the GAO to improve its record by reducing the number of hardrock mining sites that become public liabilities under Superfund (U.S. Government Accounting Office 2006).

Salmon and other anadromous fishes suffer from copper toxicity at very low concentrations. Mining the Pebble deposit would likely require wastewater treatment in perpetuity, and would store billions of pounds of un-extracted copper and other metals in permanent tailings storage

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[69] The roughly 2 billion tons of tailings proposed in the smallest 25-year mining plan (Wardrop 2011) is roughly equivalent to the total volume of soil and rocks that was hydraulically mined during the California gold rush. This estimate is roughly 8 times greater than the quantity of material that was excavated to create the Panama Canal (http://museumca.org/goldrush/fever19-hy.html).

[70] http://water.epa.gov/lawsregs/lawsguidance/cwa/economics/liquidassets/dirtywater.cfm

facilities that drain to salmon spawning and rearing habitat, and would, therefore, pose a perpetual risk to those fishery resources.

The hardrock mining industry provides employment for the life of each mine. The proponents of the Pebble Project have stated that roughly 2000 jobs would be created during the start up of its project, and some of these jobs could last as long as 78 years, should the mine operate for that long. Those jobs will disappear permanently when the mine closes.

In contrast, the Alaska salmon industry supports over 70,000 jobs that have spanned generations of Alaskans, as well as providing subsistence to native Alaskans for hundreds of years. The salmon industry in Bristol Bay alone provides employment that spans many generations of people, and with proper stewardship, can continue to do so forever.

Even if a proposal to mine the Pebble deposit could be redesigned to comply with the Guidelines, including meeting water quality standards and offsetting the direct losses of habitat, the long-term risks associated with storing and treating potentially toxic tailings in perpetuity seems contrary to the public interest. In fact, the U.S. Government Accounting Office (2006) cautioned EPA that "*Hardrock mining can cause significant environmental problems; these sites are typically large, complex, and costly to clean up. For example, in 2004, the EPA Inspector General estimated that cleaning up 63 mining sites on the Superfund's National Priorities List would cost up to $7.8 billion. In applying the Superfund law's risk-based approach for developing financial assurance requirements, EPA may want to consider hardrock mining – for example, gold, copper, and iron ore mining – a high priority because it presents taxpayers with an especially serious risk of having to pay cleanup costs for thousands of abandoned, inactive, and operating mines in the United States.*"

VI. Discussion and Conclusions

Mining the Pebble deposit will result in discharges of dredged or fill material to waters of the United States, including wetlands. EPA's authorities under Section 404(c) are closely tied to the 404(b)(1) Guidelines, which govern whether discharges of dredged or fill material are permittable. The Guidelines provide a tool to assess many elements of a project including impacts and alternatives, including, but not limited to, off-site alternatives, on-site alternatives, water quality, significant degradation, findings of non-compliance, and public interest. These issues and their relevance to EPA action are discussed in detail below.

Off-site alternatives

It appears that present sponsors of the Pebble Project (Northern Dynasty Minerals Ltd. and Anglo American) have several alternative locations where extraction of copper and associated minerals appears to be practicable, and which may be less environmentally damaging than mining the Pebble deposit. Unless these alternatives could be clearly demonstrated to be not practicable within the meaning of the Guidelines, or that such alternatives would cause greater environmental harm than mining the Pebble deposit, no permit should be issued under the Guidelines [40 CFR 230.10(a)].

On-site alternatives

As proposed in Wardrop (2011), and earlier in its 2006 water rights applications, Northern Dynasty Minerals has proposed impounding and filling drainages near the Pebble deposit for tailings storage facilities (TSF). As shown in this report, it is clear that the drainages that have been proposed by Northern Dynasty contain documented anadromous fish habitat, and loss of such habitat is considered particularly adverse environmentally. In fact, the authors could find no record since the inception of the CWA Section 404 program in 1977, of any CWA Section 404 permits being issued within Region 10, including Alaska, authorizing such large-scale filling of wild salmon habitat. Out of well over 20,000 permit applications processed in Region 10 alone, only minor fills for road crossings (bridge abutments, culverts) have been permitted to infringe on wild salmon habitat. None of these impacts were considered significant, individually or cumulatively, whereas those associated with mining the Pebble deposit would be very significant.

Other Alaska mines that are currently operating have avoided, for the most part, valuable fish habitat. For example:

- The Red Dog lead and zinc mine, the world's largest producer of zinc, is along Red Dog Creek. The ore body lies at the surface, and Red Dog Creek, which prior to its diversion for the mine flowed through the ore body, was biologically dead for several miles downstream. The south fork of Red Dog Creek was chosen for the tailings impoundment because it, too, was naturally highly contaminated and devoid of fish;

- The Fort Knox project, one of the largest open pit gold mines in the world, is near Fairbanks in an area that had been heavily placer mined prior to its development. Creeks downstream from the project were CWA 303(d) listed for sediments (*i.e.*, water quality criteria for sediment was exceeded due to the ongoing impacts of recent and historical placer mining). The siting of the Ft. Knox tailings impoundment was designed to prevent additional sediment from flowing downstream, allowing those downstream areas to recover naturally and thus improve fish habitat. The project is a zero-discharge project (*i.e.*, no effluent, no NPDES permit);

- The Pogo mine near Delta Junction is a gold mine that uses a dry-stack tailings disposal method in the headwaters of a small creek that discharges to the Goodpaster River, an anadromous stream. To avoid any potential water quality impacts to the Goodpaster River, an off-channel mixing pond was constructed that is screened to prevent fish from entering. Treated mine effluent is diluted in the mixing pond and discharged to the river, meeting water quality criteria without a mixing zone (or discharge of fill material) in the river; and

- The Kensington gold mine, 45 miles north of Juneau, went through several project designs, NEPA analyses and CWA permitting processes during the late 1980's and 1990's. In 1997, CWA permits were issued to construct a dry-stack tailings facility with a very small discharge to a small stream with very little habitat value for fish. Although fully permitted with no opposition, the applicant pursued an alternative design taking advantage of the new

definition of fill material, and obtained a permit over EPA's objections to discharge of mine tailings directly into Slate Lake.[71]

Water quality

Geochemical tests of the Pebble mine tailings and waste rock have shown the potential for long-term leaching of copper from pyritic tailings and PAG waste rock. Runoff from waste rock piles and the mine pit, which would be developed within zones of potentially acid-generating rock, would be directed to the TSF for storage prior to treatment where it would mix with tailings process water and precipitation. Although no determination can be made at this time regarding the water quality that would ultimately develop with the TSF, a preliminary assessment of wastewater treatment needs indicates treatment capacity could be orders of magnitude greater than any currently operating hardrock mine in Alaska, all of which have the benefit of dilution prior to discharge. No mixing zone could be authorized for the Pebble discharges because all receiving waters provide anadromous fish spawning and rearing habitat.

The permeable nature of the terrain underlying the site G TSF strongly suggests that, absent a dependable liner and internal drainage system, contaminated seepage would migrate to nearby streams that support anadromous fish in various life stages.

Wastewater may require treatment long after active mining operations cease due to the length of time that acid mine drainage may develop (forty years) and the quantity of leachable copper (billions of pounds) that could be retained within the tailings.

Significant degradation

Mining the Pebble deposit will destroy large areas of fish and wildlife habitats. The smallest mining proposal that is currently being considered would operate for 25 years and exploit less than 20% of the ore deposit. This smallest on-site alternative would destroy more than 9200 acres of fish and wildlife habitat, including several miles of documented anadromous waters, and many miles of tributaries to documented anadromous waters. Even if it were possible to avoid the losses and downstream degradation associated with the construction and long-term operation of tailings storage facilities and associated wastewater treatment, the construction and dewatering of the pit would result in loss and/or degradation of thousands of acres of fish and wildlife habitats, including wetlands, vegetated shallows, and anadromous waters and their tributaries. It is unlikely that these losses could be offset practicably within the Upper Talarik Creek and Koktuli River drainages, nor within the larger Bristol Bay watershed.

Moreover, the Pebble deposit includes a much larger area of mineral claims (Figure 13), including a large area held by NDM. Individually, mining the areas of the Pebble deposit that have been proposed by the Pebble Partnership would likely result in significant degradation of the waters of the United States. Additional hardrock mining of the areas of the adjacent claims would further contribute to this degradation and would likely be prohibited under the Guidelines.

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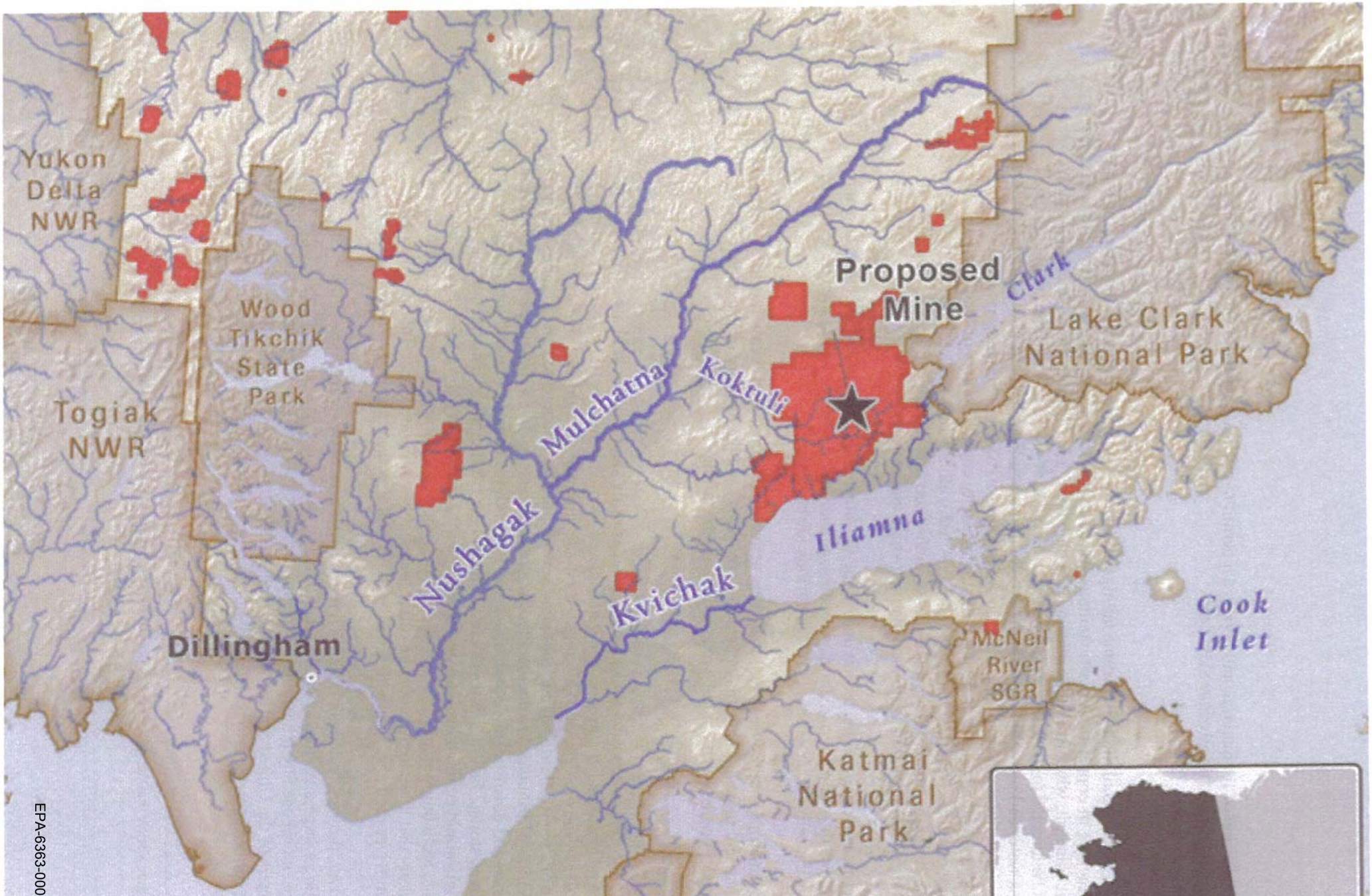
[71] It is noteworthy that the mine tailings proved toxic, repeatedly failing bioassays.



EPA-6363-0000078[illegible]

Figure 13. Mining claims in the Bristol Bay Watershed including the Pebble deposit within which the Pebble Project has been proposed (star). Figure courtesy Marcus Geist, The Nature Conservancy

Findings of non-compliance with the Guidelines

It does not appear that mining the Pebble deposit could practicably comply with the Guidelines, even if it were limited to an initial 25-year phase of development, which seems unlikely. There appear to be less environmentally damaging practicable alternatives that are available to the project proponents to achieve the basic purpose of extracting copper and associated minerals, including existing mining operations and alternative ore deposits that are already held by the project sponsors or their parent corporations.

Mining the Pebble deposit poses risks that water quality standards may be exceeded, and the fact that the deposit is in a net precipitation area, means that discharges from the tailings impoundments, waste rock disposal areas, and mine pit will occur over time. The quantity of wastewater that will require treatment is very large, and it appears that treatment would be required long after the mine is closed. If mined to its full extent, the treatment would extend to multiple tailings storage facilities, as well as the mine pit, and as much as 8 billion pounds of potentially leachable copper would need to be stored forever without migrating to nearby streams that provide anadromous fish habitat.

The habitat losses associated with mining the Pebble deposit, even for as few as 25 years, exceed those that EPA has found to be unacceptable in most of its past 404(c) actions, and the quality of the fish and wildlife habitat that would be permanently lost is unsurpassed in any of those previous 404(c) actions. Moreover, the location of the Pebble deposit, on a divide at the headwaters of three rivers, serves to multiply the environmental risks associated with potential mining operations there.

Public Interest Considerations

Even if mining the Pebble deposit was unavoidable to achieve the basic purpose of extraction of copper and associated minerals, it seems unlikely that compensatory mitigation measures could adequately offset unavoidable impacts to fish and wildlife resources. There do not appear to be opportunities, or needs, to restore degraded habitat within the drainages of the North and South Fork Koktuli Rivers or Upper Talarik Creek. Similarly, there may be no opportunities or needs to do so within the greater Bristol Bay watershed. If not, then the permanent loss of thousands of acres of wetland and aquatic areas and wildlife habitat, and many miles of anadromous waters and their tributaries would not be offset, and would result in significant degradation of the waters of the United States.

Finally, it seems contrary to the public interest to permit the permanent losses of thousands of acres of fish and wildlife habitat, and the potential long-term secondary risks to hundreds of miles of downstream waters for a hardrock mine. It does not seem to be in the short- or long-term interest of the public to trade sustainable resources that have provided permanent employment for commercial and sport fisheries, and subsistence for native Alaskans for many generations for a foreign-based industrial operation that would operate for as few as 25 years and destroy a portion of these renewable resources while creating a more-or-less permanent risk to those that would remain when the mine closes and its sponsors leave.

EPA should initiate action proactively under its 404(c) authority to restrict mining the Pebble deposit to reduce the likelihood that unacceptable environmental impacts will occur. Such action would also guide the sponsors of proposals to mine the Pebble deposit to avoid investing time and capital into proposals that are unlikely to qualify for permitting, and that might expose taxpayers to a serious risk of having to eventually pay cleanup costs for the site (U.S. Government Accounting Office 2006). EPA has previously undertaken 404(c) actions where the potential impacts were far less than the potential impacts (area impacted, habitat impacted, adverse fishery impacts, etc.) associated with very large-scale proposals to mine the Pebble deposit (Table 3). One of the criticisms associated with earlier EPA 404(c) actions was that the EPA waited too long to take action; this extended time cost project proponents millions of dollars and consumed valuable human resources.

We recommend that EPA develop and adopt specific prohibitions and restrictions on mining the Pebble deposit to provide a road map for responsible development and protection of the valuable fishery resources. The following protections, at a minimum, are recommended.

1. Prohibit the discharge of dredged or fill material from the Pebble deposit to wild salmon spawning and rearing habitat

As stated earlier, the authors could find no record of any CWA Section 404 permits being issued within Region 10, including Alaska, authorizing such large-scale filling and destruction of wild salmon habitat. Only minor fills for road crossings have been permitted, and none of these impacts were considered significant, individually or cumulatively. Those associated with mining the Pebble deposit would be very significant.

Rather than permit the direct destruction of salmon habitat, the nation has invested millions upon millions of dollars to restore wild salmon habitat. Currently a major investment of federal taxpayer's dollars is going toward the removal of two large dams on the Elwha River on the Olympic Peninsula of Washington, with the sole purpose of restoring wild salmon runs. The Condit dam on the White Salmon River in Washington is also being dismantled, and in the Klamath Basin in Oregon, a similar effort is underway to remove dams and restore wild salmon runs. Also, concerning the Columbia River, a federal judge has repeatedly ordered federal agencies (National Marine Fisheries Service, Corps of Engineers, and Bonneville Power Administration) to revise recovery plans under the Endangered Species Act to promote the restoration of many historical runs of threatened and endangered salmon and steelhead, despite the enormous costs involved.

Even at the smallest 25-year conceptual design described in Wardrop (2011), mining the Pebble deposit would directly destroy or degrade many miles of salmon spawning and rearing habitat via excavations and dewatering the mine pit and the discharge of fill material for waste rock dumps and tailings disposal facilities. Many additional miles of anadromous fish habitat would likely be indirectly degraded due to hydrologic modifications (Ecology and Environment 2010). These spawning and rearing habitats are part of a larger aquatic ecosystem that supports the world's number one wild sockeye salmon fishery, a significant part of a statewide fishery with an

overall value of several hundred millions of dollars annually (U.S. Environmental Protection Agency et.al. 1994). Such direct and indirect loss of salmon habitat could only occur if authorized by a Department of the Army permit pursuant to Section 404 of the CWA.

EPA should clearly communicate that the destruction of wild salmon habitat associated with construction and operation of a mine to extract copper and associated minerals from the Pebble deposit would not be permitted as it very clearly constitutes significant degradation of an irreplaceable aquatic resource of national, indeed international, significance and hence would not comply with 40 CFR 230.10(c).

2. Prohibit the discharge of dredged or fill material from mining the Pebble deposit that does not meet testing requirements demonstrating that such material is not toxic to aquatic life

As stated earlier, the EPA and Corps of Engineers are presently using a definition of fill material, adopted in 2002, that specifically includes "*placement of overburden, slurry, or tailings or similar mining-related materials....*" as fill material subject to the requirements of CWA Section 404 (67 FR 31192). The requirements of the Guidelines require that the discharge of any fill material to waters of the United States must be determined to be clean fill material that will not cause or contribute to violations of applicable water quality criteria.

As discussed in previous sections of this report, the data available to date indicate that tailings and waste rock would leach copper and much of the waste rock would be potentially acid-generating. The one tailings impoundment site that has been identified is underlain by relatively porous material and is saturated at the surface over much of the area. Although it is early in the mine planning process and more testing of the proposed mine waste fill material is no doubt underway, EPA should be clear that contaminated fill material that may cause acid mine drainage and/or leach toxic metals cannot be permitted under Section 404 of the CWA.

Accordingly, EPA should clearly articulate its expectation and firm position that any mine wastes from mining the Pebble deposit that are proposed to be discharged to the wetlands and streams within the project area must demonstrate unequivocally that such wastes:

- will not cause acid mine drainage. Acid-base accounting shows NP/AP ratio (neutralization potential vs. acid-generating potential) greater than 3:1 and long-term humidity cell tests on all waste products demonstrate no potential for acidification over time;

- will not leach metals in toxic amounts. Long-term humidity cell and column leach tests demonstrate that leachate from all waste products will meet Water Quality Criteria (WQC) protective of aquatic life; and

- will not have acute or chronic effects on aquatic organisms. Appropriate freshwater bioassays such as amphipod (*Hyalella Azteca*) and chironimid (*Chironomus dilutus*) show no significant mortality or abnormal growth effects.

Failure to pass these and other tests designed to determine the acute and chronic toxicity of dredged or fill material would require project proponents to dispose of and store their waste products in confined disposal sites approved by EPA, the Corps of Engineers and the State of Alaska. These are highly engineered facilities that, for a mining project, require impervious tailings dams and a fully lined tailings impoundment with internal drains to direct contaminated seepage to seepage/leachate-collection ponds for eventual treatment to meet regulatory requirements.

Providing proper containment of mine wastes that do not meet testing requirements described above would help to achieve the Guidelines requirements regarding water quality [40 CFR 230.10(b) and minimizing impacts [40 CFR 230.10(d)]. As such an approach would entail 404 authorization for the placement of an engineered liner as fill material in lieu of mine waste material, any questions regarding invoking the waste treatment exclusion would be moot. The waters of the United States under consideration would, if 404 authorization was granted, have already been removed from jurisdiction prior to the discharge of any mining waste byproducts.

3. Prohibit the discharges of dredged or fill material from mining the Pebble deposit where runoff and seepage would require treatment in perpetuity

Based upon the data available, it cannot be determined at this time how long wastewater associated with the mine waste (tailings and waste rock) fill material would require treatment before project site water quality returns to pre-project levels. As stated by Northern Dynasty Mines, Inc. (2005a) "*the overall timeframe for acidification of waste rock from the Pebble Project appears to vary from zero to forty years.*" Given the potential for mining up to and beyond the 78-year scenario, it is highly conceivable that wastewater treatment facilities on a massive scale would be required for well over a century. There is significant uncertainty regarding how long and in what quantities metals, including potentially billions of pounds of copper, may leach from tailings and waste rock. At many abandoned mine sites throughout the American west, acid mine drainage contaminated with metals has persisted for decades without abatement (U.S. Government Accounting Office 2006). Given the extraordinarily high value of the fisheries resources of the Bristol Bay watershed and their increasing rarity worldwide, as well as the enormous and unprecedented quantity of potentially acid-generating and copper-leaching mine waste that mining the Pebble deposit would produce, state and federal regulators should have a firm understanding of how long project permits and associated wastewater treatment would be required prior to granting any potentially "open-ended" permits.

To the best of our knowledge, no currently permitted and operating mine in Alaska or anywhere in EPA Region 10 has received CWA permits with the understanding and/or expectation that wastewater discharges from such facilities (*e.g.*, tailings ponds) would require treatment in perpetuity. Only the Red Dog lead and zinc mine in northwest Alaska is now anticipated to be in that unfortunate category (personal communication, Patricia McGrath, former Regional Mining Coordinator, EPA Region 10, Sept. 29, 2011).

However, when the Red Dog mine was originally permitted in the 1980's, there were no requirements for a reclamation plan (now a State of Alaska requirement). Nevertheless, the mine operator, Cominco, did develop a conceptual closure plan that anticipated treating and draining

all tailings pond water and then allowing the tailings and associated mine waste piles to freeze (Red Dog Mine FEIS, 1984). The mine is 100 miles north of the Arctic Circle, in an area predominated by permafrost. Unfortunately, the project planners did not anticipate the exothermic reaction that occurs when sulfides contained in the ore, tailings and waste rock contact the atmosphere and oxidize. This chemical reaction at the Red Dog mine has generated so much heat that studies are now underway to determine the extent to which permafrost beneath the tailings impoundment may be melting. In fact, the waste rock piles have literally caught fire from heat generated by these chemical reactions.

Other considerations argue for a clear prohibition against permitting projects whose wastewater treatment needs are likely to persist for many decades if not centuries after operations cease, including:

- Financial bonding for wastewater treatment at the magnitude currently envisioned would be exceedingly difficult, perhaps impossible, to obtain (U.S. Government Accounting Office 2006). The liabilities associated with guaranteeing water quality and flow regimes far into the future for waters that support an anadromous fishery of such immense value would certainly be greater than for any mining facility permitted to date (Table 1);

- The states of Michigan and New Mexico have already enacted regulations that prohibit permitting mining projects if it cannot be determined with certainty when treatment would no longer be required. This policy should be emulated at the federal level; and

- The State of Washington Pollution Control Hearings Board overturned state water quality and water rights permits for the Crown Jewel open-pit gold mine project in Okanogan County based on predictions that the pit lake water would require treatment in perpetuity. As stated by Tom Fitzsimmons, then Director of the Washington State Department of Ecology *"Many projects rely on scientific modeling to predict how the environment might be harmed or altered and ways to compensate for those effects. The board's decision signals that proponents of these kinds of projects must be prepared to thoroughly tackle questions of uncertainty when developing plans to restore lands where the environment is markedly changed."*

In summary, we conclude that on-going proposals to mine the Pebble deposit would not qualify for permitting under the Clean Water Act regulations pursuant to Section 404. We believe there are less damaging alternatives to extract copper and associated minerals that are available to the project proponents. We also believe that the short- and long-term challenges associated with the isolation, capture, and treatment of leachate and runoff from tailings, waste rock, and the mine pit present a high risk of violating water quality criteria. The direct losses of fish and wildlife habitat would far exceed that of any private development for which EPA has exercised its 404(c) authority in the past, and there appear to be few if any means to offset these losses within the Bristol Bay watershed. Simply put, on-going proposals to mine the Pebble deposit would have unacceptable adverse effects on waters of the United States.

In reaching our conclusions, we have relied primarily upon information developed by companies seeking to extract copper and associated minerals from the Pebble deposit, but we also recognize

that there is, as yet, no formal proposal and that it is not possible for us to predict exactly where regulated discharges will be proposed. Similarly we recognize that there are other mineral claims within the watershed that could also be proposed for mining.

In recognition of these uncertainties, we have focused on what is known. We know that the Bristol Bay watershed supports an unparalleled anadromous fishery resource and that the river systems that emanate from the area of the Pebble deposit are known habitat for these anadromous fishes. We know that the size and geochemical nature of the Pebble deposit will lead to discharges of unprecedented quantities of mine waste, with the potential to develop acid mine drainage and leach copper, that will need to be stored in perpetuity within and adjacent to wild salmon spawning and rearing habitat.

Given the present uncertainty of the specifics of plans to mine the Pebble deposit compared to the certainty of environmental risks, we have concluded that the most positive regulatory and environmental action that EPA can take is to proactively adopt restrictions on mining the Pebble deposit – restrictions that are well within EPA's existing authorities and consistent with its existing policies – to protect the known fishery resources and to minimize the risks to those fishery resources from hardrock mining.

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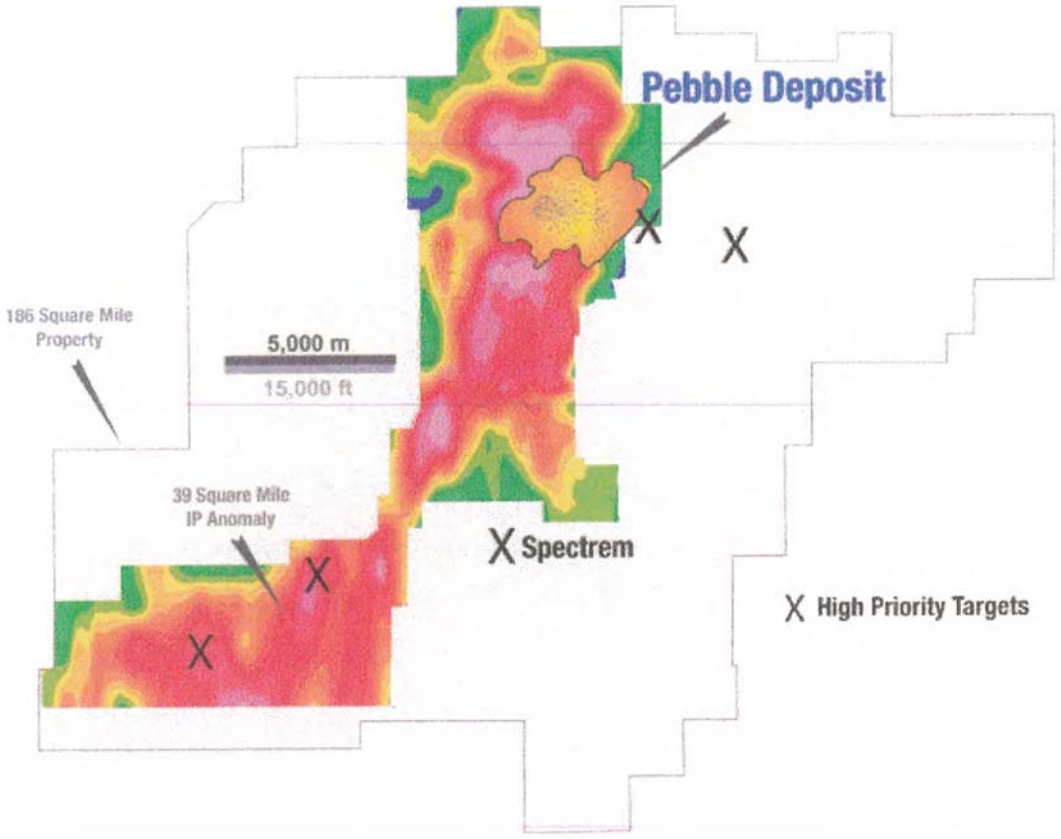
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